APPENDIX I

METHODOLOGY FOR CALCULATING TMDLs FOR IMPAIRED BEACHES AND CREEKS AND ALLOCATING TMDLs TO SOURCES

I.1 Introduction

This appendix describes the methodology for calculating TMDLs for impaired beaches and creeks and allocating the allowable bacteria loads to sources in each watershed. Existing bacteria loads and TMDLs were first calculated in each watershed with the use of computer models. Because the climate in southern California has two distinct hydrological patterns (wet and dry), two models were developed for estimating bacteria loads. Additionally, TMDLs were calculated using interim and final phase numeric targets for both wet and dry weather.

In the San Diego Region, storms tend to be episodic and short in duration, and characterized by rapid wash-off and transport of very high bacteria loads from all land use types. The wet weather model used for TMDL calculation was USEPA's Loading Simulation Program in C++ (LSPC). LSPC was used to estimate bacteria loading from streams and assimilation within the waterbodies, and specifically quantified loading during wet weather events, defined as 0.2 inches of rain and the 72 hours that follow. LSPC is a recoded C++ version of the USEPA's Hydrological Simulation Program–FORTRAN (HSPF) that relies on fundamental (and USEPA-approved) algorithms. A complete discussion of LSPC configuration, calibration, and application is provided in Appendix J.

In contrast, bacteria loading under dry weather conditions was found to be much smaller in magnitude, did not occur from all land use types, and exhibited less variability over time. To represent the linkage between source contributions and in-stream response, a steady-state mass balance model was developed to simulate transport of bacteria in the impaired creeks and the creeks flowing to impaired shorelines. This predictive model represented the streams as a series of plug-flow reactors, with each reactor having a constant, steady-state flow and bacteria load. A complete discussion of the development of the empirical framework for estimating watershed loads, and a description of the configuration and calibration of the stream-modeling network is provided in Appendix K. In addition to estimating current loading, both models were used to estimate TMDLs for the two climate conditions for each watershed. Assumptions made for both wet weather and dry weather modeling can be found in Appendix L.

This appendix describes the methodology for calculating TMDLs using the wet and dry weather modeling results, and using interim and final numeric targets. Section I.2 of this appendix describes the interim and final numeric targets that were used to calculate both wet weather and dry weather TMDLs. Section I.3 discusses the use of load-duration curves, which were instrumental in calculating wet weather TMDLs from model output. Section I.4 discusses the derivation of interim wet weather TMDLs and allocations.

Section I.5 discusses the derivation of final wet weather TMDLs and allocations. Section I.6 discusses the derivation of interim and final dry weather TMDLs and allocations.

In all cases, bacteria sources were quantified by land-use type since bacteria loading can be highly correlated with land-use practices. For purposes of implementation, land use practices were grouped according to the most likely method of regulation by the San Diego Water Board of bacteria discharges from the land use type.

I.2 Numeric Target Selection for Wet Weather and Dry Weather TMDLs

When calculating TMDLs, numeric targets must be established to meet water quality objectives (WQOs) and subsequently ensure the protection of beneficial uses. The numeric targets used in these TMDL calculations were equal to the WQOs for bacteria for either REC-1 (water-contact recreation) or SHELL (shellfish harvesting) beneficial uses. Numeric targets applicable to beaches were also used for impaired creeks for the reasons discussed in section 4 of the Technical Report.

Different dry weather and wet weather numeric targets were used because the bacteria transport mechanisms to receiving waters are different under wet and dry weather conditions. Single sample maximum WQOs were used as wet weather numeric targets because wet weather, or storm flow, is episodic and short in duration, and characterized by rapid wash-off and transport of high bacteria loads, with short residence times, from all land use types to receiving waters. Geometric mean WQOs were used as numeric targets for dry weather periods because dry weather runoff is not generated from storm flows, is not uniformly linked to every land use, and is more uniform than stormflow, with lower flows, lower loads, and slower transport, making die-off and/or amplification processes more important.

Another difference between the wet weather and dry weather TMDL calculations, besides the use of single sample maximum WQOs versus geometric mean WQOs, is that the wet weather TMDLs (during the interim period, only) are calculated using a reference system approach. The purpose of the reference system approach is to account for the natural, and largely uncontrollable sources of bacteria (e.g., bird and wildlife feces) in the wet weather loads generated in the watersheds and at the beaches that can, by themselves, cause exceedances of WQOs.

The reference system approach is utilized in the TMDL by allowing a 22 percent exceedance frequency of the single sample WQOs for REC-1. Twenty-two percent is the frequency of exceedance of the single sample maximum WQOs measured in a reference system in Los Angeles County. A reference system is a beach and upstream watershed that are minimally impacted by anthropogenic activities. A reference system typically has at least 95 percent open space.

The final wet weather TMDLs must meet WQOs in the receiving water without application of a reference system approach because, at this time, the Water Quality Control Plan for the San Diego Basin (Basin Plan) does not authorize the implementation of single sample bacteria WQOs using this approach. A Basin Plan amendment authorizing implementation of single sample bacteria WQOs using a reference system approach is being developed by the San Diego Water Board[1] under a separate effort from this TMDL project.

In contrast to wet weather, implementing the dry weather numeric targets with a reference system approach is not appropriate. A reference system approach is not applicable to dry weather TMDL calculation because numeric targets are based on the geometric mean WQOs. A reference system approach uses an allowable exceedance frequency—meaning the number of times the ***single sample maximum*** WQOs are exceeded in a reference system—to calculate TMDLs. An allowable exceedance frequency is not relevant to a geometric mean because the geometric mean is an average value over the course of 30 days.

I.3 Using Load Duration Curves to Calculate Wet Weather TMDLs

For the wet weather analysis, existing loads and TMDLs were calculated using output from the LSPC watershed model. To ensure that WQOs are met in impaired waterbodies during wet weather events, a critical period associated with extreme wet conditions was selected for TMDL calculations. The year 1993 was selected as the critical wet period for assessment of extreme wet weather loading conditions because this year was the wettest year of the 12 years of record (1990 through 2002) evaluated in the TMDL analysis. This corresponds to the 92nd percentile of annual rainfalls for those 12 years measured at multiple rainfall gages in the San Diego Region.

Model output was used to produce load-duration curves, such as the one shown in Figure I-1. Load-duration curves are bar graphs that display information for a specific watershed mouth (watersheds were delineated into smaller subwatersheds for loading analysis). In other words, each subwatershed has a unique load-duration curve. The y-axis shows the bacteria load (billion most-probable-number, or MPN/day) associated with the flow for a given day. Each daily wet weather load is represented by a bar. The bars are ranked across the x-axis according to the magnitude of the associated daily flow from lowest to highest. Appendices O and P show load-duration curves for each modeled subwatershed, for each type of bacteria. Appendix O shows load-duration curves associated with interim numeric targets, which incorporate the reference system approach, while Appendix P shows load-duration curves associated with final numeric targets, which do not incorporate the reference system approach. Figure I-1 shows model-calculated fecal coliform loads for one of the Aliso Creek subwatersheds (identified as subwatershed number 202).

Daily bacteria loads (each yellow bar) are equal to the modeled average daily flow for the wet day times the average daily bacteria density for that day. The height of the bars indicates the most probable number of fecal coliform colonies corresponding to the flow on a given day. The dark line running across the bar graph (referred to as the "numeric target line") represents the applicable WQO. The y-value of the numeric target line at any point on the graph represents the total maximum bacteria load that would not result

[1] This Basin Plan issue ranked seventh on the 2004 Triennial Review list of priority projects.

in an exceedance of the WQO for the flow on that day. The summation of the loads below the numeric target line represents the loading capacity of the waterbody on an annual basis that will not cause numeric targets to be exceeded.

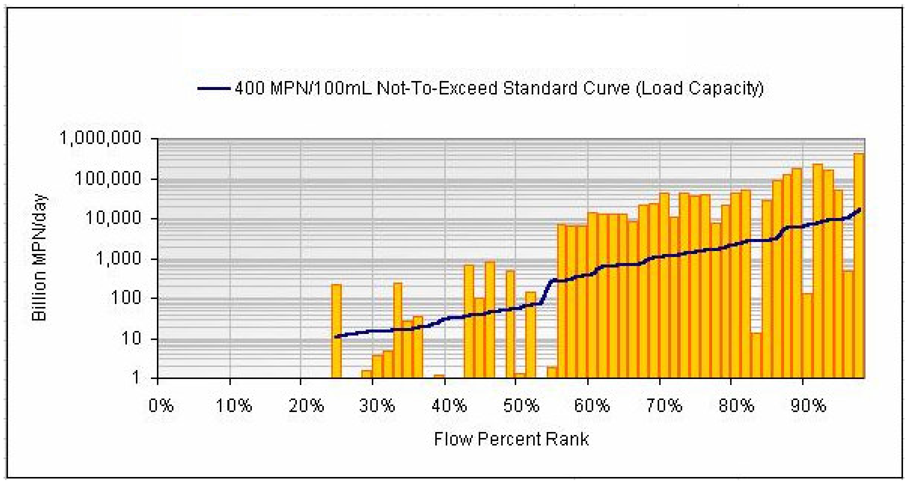
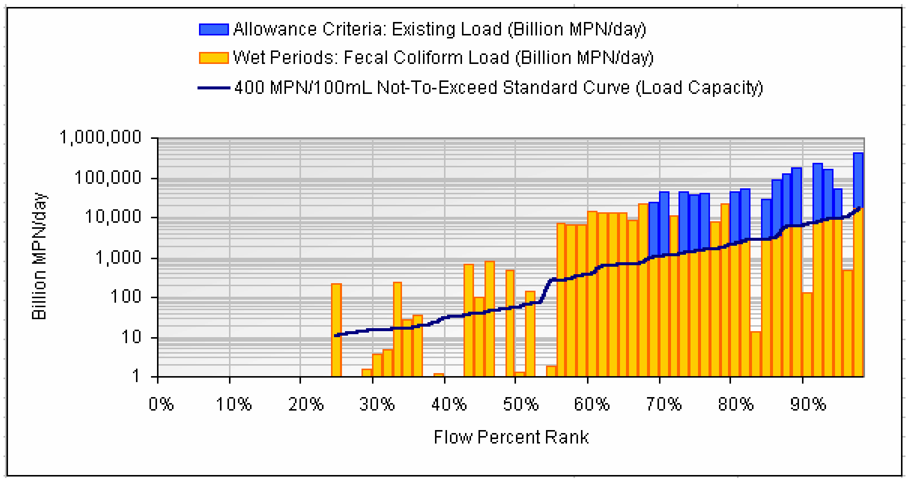


Figure I-1. Load Duration Curve for Aliso Creek Subwatershed # 202

Load-duration curves are useful for quantifying the total load for existing conditions (during the critical period), and the allowable loads (TMDLs) that must not be exceeded in order to attain WQOs. The portions of the bars that exceed the numeric target line represent loads that are in excess of the TMDL, and must be reduced by dischargers. Section I.4 shows how load-duration curves were used to calculate TMDLs using interim numeric targets and section I.5 shows how load-duration curves were used to calculate TMDLs using final numeric targets. In all wet weather analyses, TMDLs are expressed on a yearly basis (billion MPN/year) because of the extremely high daily variability in storm flow magnitude and loading in the watersheds addressed by these TMDLs. The variability in the modeled daily loads is evident in the load duration curves in Appendices O and P.

I.4 Calculation of Interim Wet Weather TMDLs and Allocations

As mentioned previously, interim TMDLs for recreational uses incorporated the reference system approach. Since storm flow loading in reference watersheds causes exceedances of single sample water quality objectives, TMDLs for urban watersheds should allow the single sample WQOs to be exceeded at the same frequency as in a similar reference system. Load duration curves were used to calculate allowable exceedance loads from allowable exceedance days for interim wet weather TMDLs. A load-duration curve showing the application of the reference system approach is shown in Figure I-2.



Fecal Coliform Loading Summary	Value	Units
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	34	None
Total Load for Existing Condition (Total Load)	1,732,709	Billion MPN/Year
Non-allowable Exceedance Load (Exceedance Load)	170,116	Billion MPN/Year
Allowable Load = (Total Load - Exceedance Load)	1,562,594	Billion MPN/Year
Percent Reduction Required from Existing Condition	**9.8%**	**Percentage**

Figure I-2. Load Duration Curve for Aliso Creek Subwatershed #202 Using Reference system Approach

Allowable exceedance loads calculated using the reference system exceedance frequency of 22 percent are represented by the blue-shaded portions of the bars in the load-duration curve. The methodology for calculating and allocating the TMDLs for each watershed is described in the following steps:

Step 1. Quantify Allowable Exceedance Loads;
Step 2. Quantify Existing Bacteria Loads and TMDLs;
Step 3. Classify Land Use Types as Point and Nonpoint Sources, and Classify Nonpoint Sources as Controllable or Uncontrollable;
Step 4. Quantify Relative Contribution of Bacteria Loads From Each Land Use Type;
Step 5. Separate Caltrans Existing Loads from Loads Generated by Industrial/Transportation Land Use;
Step 6. Combine Land Use Types Based on Method of Regulation by the San Diego Water Board; and
Step 7. Distribute TMDL Among Four Discharger Categories.

Step 1 shows the methodology used to account for allowable exceedance loads based on the frequency of exceedance of WQOs at a reference system. Step 2 shows how information from the load-duration curves is extracted to quantify current bacteria loads and TMDLs. Steps 3-5 show how existing loads are quantified from identified sources. Steps 6-7 show how the TMDLs are distributed among discharge categories. Sample calculations are provided showing all the steps involved.

1. Quantify Allowable Exceedance Loads

The first step was to quantify the allowable exceedance load associated with a 22 percent exceedance frequently The blue-colored portions of the bars (above the numeric target line) in Figure I-2 correspond to the 22 percent exceedance frequency allowed for loading from uncontrollable sources. The blue bars above the lines represent the reference system loading capacity of the waterbody on an annual basis that will not cause the numeric targets to be exceeded on more than 22 percent of the wet days (this was the observed exceedance frequency in the reference system). The portions of the bars below the numeric target line plus the blue portions of the bars above the numeric target line are equal to the allowable loads, or total maximum annual wet weather loads, for the subwatershed.

The number of allowable exceedance days for each subwatershed was calculated as follows. For each watershed, the number of wet days in 1993 was documented (Technical Report, Table 8-1). The number of days that exceedances of numeric targets are allowed for each particular watershed is obtained by multiplying the number of wet days by the exceedance frequency (Table 8-2). For example, the Aliso Creek watershed had 69 wet days in 1993. The allowable exceedance frequency of the wet weather numeric targets under the reference system approach is 22 percent. Therefore, the number of allowable exceedance days for the Aliso Creek watershed is:

$$69 \text{ Wet Days} * 0.22 = 15 \text{ Allowable Exceedance Days}$$

The allowable exceedance load was calculated by summing the loads above the numeric target line for the allowable exceedance days. These loads are shown as blue portions of the bars above the numeric target line on the load-duration curves. The 15 days with the highest loads were chosen as the allowable exceedance days because the highest loads in most of the watersheds correspond to open space land uses where bacteria loads are generated from natural sources. The remaining orange portions of the bars with magnitudes above the numeric target line represent exceedance loads that must be reduced Using the chart associated with Figure I-2, the allowable load, or TMDL, is equal to the Total Load for Existing Conditions minus the Non-Allowable Exceedance Loads caused by anthropogenic sources (orange portions of the bars above the numeric target line). For this particular subwatershed, the Allowable Load is quantified in the chart associated with Figure I-2 as 1,562,594 billion MPN/year.

2. Quantify Existing Bacteria Loads and TMDLs

Just as the allowable exceedance loads were quantified in step 1, the total existing loads, including those from anthropogenic sources, can also be found from load-duration curves. An example showing the quantification of the existing fecal coliform load and TMDL for the Aliso Creek watershed is shown below.

The bacteria load from the Aliso Creek watershed is comprised of loads from subwatershed numbers 201 and 202 (these two subwatersheds are adjacent to the Pacific Ocean and are cumulative of the upstream watersheds). Numerical values were obtained from the charts associated with the load-duration curves for the Aliso Creek watershed, specifically Tables O-16 and O-19 (Appendix O) for this example. The "Total Load For Existing Condition" (Total Load) and the TMDL for the Aliso Creek watershed is the sum of the "Total Load for Existing Conditions" for subwatersheds 201 and 202 from Tables O-16 and O-19, respectively. The "TMDL" for the Aliso Creek watershed is the sum of the "Allowable Load" for subwatersheds 201 and 202 from Tables O-16 and O-19, respectively. The Total Load and the TMDL for the Aliso Creek watershed are calculated in the following equations.

$$\begin{aligned}\text{Total Load} &= (\text{Total Load})_{\text{Subwatershed 201}} + (\text{Total Load})_{\text{Subwatershed 202}} \\ &= 19{,}386 \text{ billion MPN/mL} + 1{,}732{,}709 \text{ billion MPN/mL} \\ &= 1{,}752{,}095 \text{ billion MPN/mL}\end{aligned}$$

$$\begin{aligned}\text{TMDL} &= (\text{Allowable Load})_{\text{Subwatershed 201}} + (\text{Allowable Load})_{\text{Subwatershed 202}} \\ &= 16{,}480 \text{ billion MPN/mL} + 1{,}562{,}594 \text{ billion MPN/mL} \\ &= 1{,}579{,}074 \text{ billion MPN/mL}\end{aligned}$$

Table I-1 shows the interim wet weather TMDLs on an annual basis for all major watersheds included in this project for fecal coliform, total coliform, and enterococci bacteria, which were derived from the load-duration curves in Appendix O.

Table I-1. Interim Wet Weather TMDLs (Billion MPN/Year)

Watershed	Fecal Coliform TMDLs	Total Coliform TMDLs	Enterococci TMDLs
Laguna/San Joaquin	664,634	7,445,650	782,798
Aliso Creek	1,579,074	20,190,798	1,950,980
Dana Point	377,313	6,031,472	462,306
San Juan Creek	14,714,833	122,879,189	12,152,446
San Clemente	1,378,930	15,147,590	1,563,186
San Luis Rey River	32,445,470	224,189,156	17,470,687
San Marcos	17,224	425,083	32,966
San Dieguito River	21,106,683	159,978,672	14,327,364
Miramar	10,256	210,182	11,405
Scripps	176,906	4,356,972	324,033
San Diego River	4,681,150	66,114,283	6,591,843
Chollas Creek	520,440	13,247,626	1,152,645

3. Classify Land Use Types as Point or Nonpoint Sources, and Classify Nonpoint Sources as Controllable or Uncontrollable

For purposes of TMDL allocation to sources, all land use types were classified based on whether or not they generated mainly point or nonpoint sources of bacteria. Nonpoint source land use categories were further divided into controllable or uncontrollable sources. The classification of a land use as generating either point or nonpoint sources was based on the likelihood that the land use was urban and would occur in an area drained by municipal separate storm sewer systems (MS4s), or was rural and outside of MS4 drained areas. The rationale for identifying specific responsible dischargers is discussed in the Technical Report, sections 10 and 11.

Point sources are defined as "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged" [CWA section 502(6)]. Land use types considered urban and generating mostly point source loads from storm drain discharges were identified as:

- Low Density Residential;
- High Density Residential;
- Commercial/Institutional;
- Industrial/Transportation (excluding areas owned by Caltrans);
- Caltrans;
- Military;
- Parks/Recreation; and
- Transitional (construction activities).

Bacteria loads from these land use types were classified as point sources because, although they may be diffuse in origin, these land uses are typically found in urbanized areas, and the pollutant loading is transported and discharged to receiving waters through MS4s. MS4s are considered point sources because they discharge waste out of a discrete pipe. The principal MS4s contributing bacteria to receiving waters are owned or operated by either municipalities located throughout the watersheds or the California Department of Transportation (Caltrans). Municipal and Caltrans MS4 discharges are regulated separately under different NPDES requirements. For this reason, in each watershed, loads generated by Caltrans were separated from loads generated by Municipal MS4s.

Land use types considered rural and outside of areas drained by MS4s were identified as:

- Agriculture;
- Dairy/Intensive Livestock;
- Horse Ranches;
- Open Recreation;
- Open Space; and
- Water.

Bacteria loads from these land use types were classified as nonpoint sources because bacteria-laden discharges from these land uses are diffuse in origin, and originate in areas without constructed (man-made) MS4s. Nonpoint sources were separated into controllable and uncontrollable categories. Controllable sources included those found in the following land-use types: Agriculture, Dairy/Intensive Livestock, and Horse Ranches. These were considered controllable because the land uses are anthropogenic in nature, and load reductions can be reasonably expected with the implementation of suitable management measures. For implementation purposes, controllable nonpoint source discharges are recognized as originating from activities related to agriculture, livestock, and horse ranch facilities. For this reason, these types of discharges were given load allocations (LAs) and were required to reduce their bacteria loads if they constitute more than 5 percent of the total TMDL (see step 7 for methodology for calculating LAs).

Uncontrollable nonpoint sources include loads from Open Recreation, Open Space, and Water land uses. Loads from these areas were considered uncontrollable because they come from natural sources (e.g. bird and wildlife feces) rather than anthropogenic sources. LAs from these sources were developed, but there were no accompanying load reductions expected since these sources are natural, largely uncontrollable, and regulation is not warranted.

4. <u>Quantify Relative Contribution of Bacteria Loads From Each Land Use Type</u>
The sum of all bars in the load-duration curves provides an estimate of the total load expected in each watershed during the critical condition (rainfall conditions documented in 1993). The watershed model results were used to calculate the percent contribution from each of the 13 land use types to the total existing load (see Appendix J for discussion). Pie charts, like Figure I-3 below, shows these percentages for each watershed. Loads from each land use type were calculated by multiplying the existing load for the watershed by the percentages in the pie charts. Pie charts for each watershed are presented in Figures I-5 through I-40.

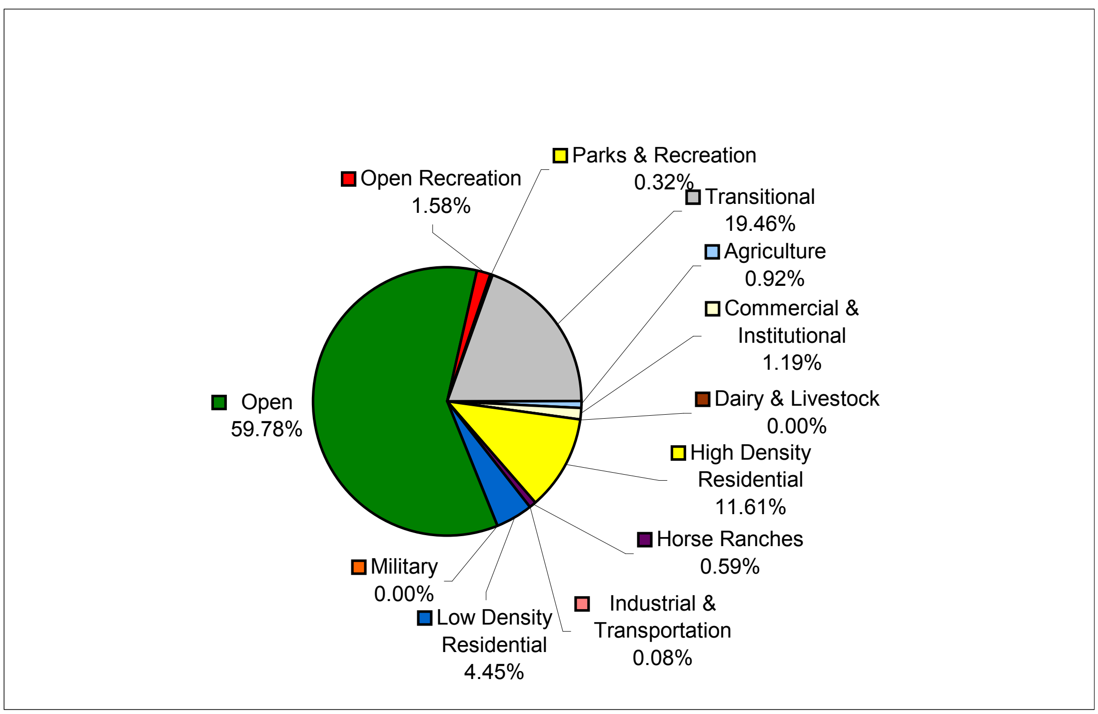


Figure I-3. Percent of Fecal Coliform Load Generated by Different Land Uses in the Aliso Creek Watershed

For example, the existing load from all sources to the Aliso Creek watershed is 1,752,095 billion MPN/year (Table O-16, O-19, Appendix O). The relative load from the High Density Residential land use can be calculated as follows:

Existing Load from High Density Residential	= 1,752,095 billion MPN/year * 11.61%
	= 203,418 billion MPN/year

Relative loads from all land use types, in all watersheds and each indicator bacteria are presented in Tables I-12 through I-14.

5. <u>Separate Caltrans Existing Loads from Loads Generated by Industrial/Transportation Land Use</u>

Highways owned by Caltrans are lumped into the industrial and transportation land use category. Bacteria loads generated from Caltrans highways need to be quantified separately from the Industrial/Transportation land use, since ultimately discharges from Caltrans highways are regulated under their own set of waste discharge requirements (WDRs) implementing National Pollutant Discharge Elimination System (NPDES) regulations. Caltrans land use areas were not delineated in the geographic information system (GIS) data used in the wet weather modeling analysis. Thus, relative loads contributed by Caltrans could not be extracted directly from the watershed model results. To calculate an existing load from Caltrans, the area occupied by impermeable Caltrans owned highway surfaces was expressed as a percent of the total area occupied by the Industrial/Transportation land use, for each watershed. The area occupied by Caltrans in each of the impaired watersheds was provided by Caltrans (Richard Watson, Caltrans, personal communication, September 23, 2005) as shown in Table I-2.

Using this information, the existing loads associated with the Industrial/Transportation land use was divided into two sources; one generated by the Municipal MS4s and one generated by Caltrans based on the percent of the total Industrial/Transportation land use area occupied by impermeable Caltrans' highways.

Table I-2. Caltrans Occupied Areas in Each Impaired Watershed

Watershed	Caltrans Occupied Area (sq miles)
Laguna/San Joaquin	0.19
Aliso Creek	0.17
Dana Point	0.06
San Juan Creek	0.73
San Clemente	0.18
San Luis Rey	1.17
San Marcos	0.01
San Dieguito	0.78
Miramar	0.74
Scripps	0.00
San Diego River	1.94
Chollas Creek	0.57

An example calculation for the Aliso Creek watershed is shown below.

Industrial/Transportation land use area = 0.89 sq miles (Table J-1 in Appendix J)

Caltrans occupied area = 0.17 sq miles (Table I-2)

The percent of the Industrial/Transportation land use area that is occupied by Caltrans is:

$$\frac{0.17\ \textit{sq miles}}{0.89\ \textit{sq miles}} = 0.191 = 19.1\%$$

The existing loads generated by Caltrans were obtained by multiplying the percent area occupied by Caltrans by the loads generated by the Industrial/Transportation land use (Table I-10):

Existing Fecal Coliform Load Generated by Caltrans = (Percent of land use occupied by Caltrans) * (Existing Fecal Coliform Load Generated by the Industrial/Transportation land use)
= 0.191 * 1,402 billion MPN/year
= 268 billion MPN/year

For three watersheds, Laguna/San Joaquin, and Dana Point, the Caltrans occupied area was reported as being larger than the area reported for the Industrial/Transportation land use. The Caltrans data are more current (2005) than the GIS land use data (2000), thus, the discrepancy is most likely due to new highway construction since 2000 by Caltrans in these watersheds. In these cases, the loads generated by the Industrial/ Transportation land use were attributed solely by Caltrans.

The loads generated by Caltrans calculated from the above methodology in the remaining watersheds are shown in Tables I-15 through I-17.

6. Combine Land Use Types Based on Method of Regulation by the San Diego Water Board

After the existing loads were calculated from each land use type (sources) in steps 4 and 5, the land use types were then combined into one of four discharge categories. These categories were based on the manner in which discharges associated with these land uses are regulated by the San Diego Water Board. The land uses were grouped into the following four discharge categories:

Municipal MS4s	= Sum of existing loads generated from Low Density Residential, High Density Residential, Commercial/Institutional, Industrial/Transportation (excluding Caltrans), Military, Parks/Recreation, and Transitional land uses
Caltrans	= Existing load calculated from step 5
Agriculture/Livestock Operations (Ag/Livestock)	= Sum of existing loads from Agriculture, Dairy/Intensive Livestock, and Horse Ranches land uses
Undeveloped Land (Open Space)	= Sum of existing loads from Open Recreation, Open Space, and Water land uses

Discharges from the various land use types were grouped into these four categories for implementation purposes. Section 11 of the Technical Report discusses implementation of the TMDLs.

7. Allocate TMDL to the Four Discharge Categories

Once TMDLs were determined in step 2, they were allocated to the four discharge categories described in step 6. Wasteload allocations (WLAs) were assigned to point source discharges and load allocations (LAs) were assigned to nonpoint source discharges. The TMDLs were distributed as follows:

$$TMDL = WLA(Municipal\,MS4s) + WLA(Caltrans) + LA(Ag\,/\,Livestock) + LA(Open\ Space)$$

where *TMDL* = Total Maximum Daily Load for entire watershed
WLA (Municipal MS4s) = Wasteload allocation for owners/operators of Municipal MS4s
WLA (Caltrans) = Wasteload allocation for Caltrans

LA (Ag/Livestock) = Load allocation for owners/operators of agriculture, livestock, and horse ranch facilities
LA (Open Space) = Load allocation for uncontrollable sources of bacteria

Since loads from Open Space, Open Recreation, and Water land uses are uncontrollable, the LAs for this category cannot be lower than the existing loads. Therefore the LAs for this category are the same as the existing loads generated by uncontrollable sources, as calculated from step 4, and cannot be reduced.

Similarly, for Caltrans, the WLAs are identical to the existing loads generated by Caltrans in each watershed. However, the reasoning for this determination is different than the reasoning described for loading from uncontrollable sources. Inspection of Figures I-5 through I-40 indicate that wet weather loading from the Industrial/Transportation land use is less than 1 percent of the total existing load in all watersheds. Furthermore, Caltrans occupies a portion of this land use (Tables I-15 through I-17). Since Caltrans is an insignificant bacteria source compared to other controllable sources, the San Diego Water Board shall not impose stricter regulation than what is already in place (see section 11.5.2 for a description of regulation of Caltrans with respect to these TMDLs). Therefore, no reductions are required for Caltrans.

The methodology used for distributing the remaining portions of the TMDL between the Municipal MS4s and the Ag/Livestock categories depended on whether or not the relative bacteria loads contributed by agriculture, livestock, and horse ranch facilities were significant compared to loads from urbanized areas. Although allocations are distributed to the identified dischargers of bacteria, this does not imply that other potential sources do not exist. Any potential sources in the watersheds, such as publicly owned treatment works, not receiving an explicit allocation as described above is allowed a zero discharge of bacteria to the impaired beaches and creeks.

a) Methodology When Ag/Livestock Sources are an Insignificant Portion of the Total Existing Load

Figures I-5 through I-40 demonstrate that in the San Joaquin Hills, Laguna Beach, Aliso Creek, Dana Point, San Clemente, Miramar, Scripps, San Diego River, and Chollas Creek watersheds, the proportion of the total existing load for all 3 indicator bacteria due to agriculture, livestock, and horse ranch facilities (loads associated with Agriculture, Dairy/Intensive Livestock, and Horse Ranches land uses) is less than 5 percent. For these watersheds, the LAs for agriculture, livestock, and horse ranch facilities are identical to existing loads calculated from these land uses. As with Caltrans and Open Space, LAs are given to agriculture, livestock, and horse ranch facilities; however no load reductions are required since these sources are insignificant compared to existing loads generated by urban sources in these watersheds. Therefore Municipal MS4s alone are required to reduce bacteria loads during wet weather events in these watersheds to meet the TMDLs.

WLAs for municipal MS4s are given by:

$$WLA(Municipal\ MS4s) = TMDL - WLA(Caltrans) - LA(Ag\ /\ Livestock) - LA(Open\ Space)$$

In the above equation, WLAs for Caltrans, LAs for agriculture, livestock, and horse ranch facilities, and LAs for uncontrollable sources are equal to existing loads from these sources as determined in steps 4 and 5. Using the Aliso Creek watershed as an example, the WLA for Municipal MS4s can be calculated using Table I-10. The WLA for fecal coliform for Municipal MS4s is

WLA (Municipal MS4s) = [1,579,074 – 268 – 26,457 – 1,075,085] billion MPN/year

= 477,264 billion MPN/year

The percent reduction required for fecal coliform for the Municipal MS4s in the Aliso Creek watershed is

$$Percent\ Reduction = \frac{(Existing\ Load\ From\ Municipal\ MS4s - WLA\ (Municipal\ MS4s))}{Existing\ Load\ From\ Municipal\ MS4s}$$

$$= \frac{(649{,}935\ billion\ MPN\ /\ year - 477{,}264\ billion\ MPN\ /\ year)}{649{,}935\ billion\ MPN\ /\ year}$$

= 0.266
= 26.6%

b) Methodology When Ag/Livestock Sources are a Significant Portion of the Total Existing Load

In the San Juan Creek, San Luis Rey River, San Marcos Creek, and San Dieguito River watersheds, the agriculture, livestock, and horse ranch facilities generate more than 5 percent of the total wet weather load for all three indicator bacteria. Table I-3 shows the percent contribution of bacteria from agriculture, livestock, and horse ranch facilities to the total existing load in each watershed. This information is derived from the pie charts (Figures I-5 through I-40).

Table I-3. Percent Contribution of Bacteria from Agriculture, Livestock, and Horse Ranch Facilities to the Total Existing Loads

Watershed	Percent of Existing Fecal Coliform Load	Percent of Existing Total Coliform Load	Percent of Existing Enterococci Load
Laguna/San Joaquin	1.04	0.62	0.37
Aliso Creek	1.51	0.77	0.51
Dana Point	0.00	0.00	0.00
San Juan Creek	21.40	14.21	8.87
San Clemente	0.03	0.01	0.01
San Luis Rey	62.46	50.67	37.32
San Marcos	53.62	23.76	19.30
San Dieguito	55.77	42.53	29.89
Miramar	0.00	0.00	0.00
Scripps	0.00	0.00	0.00
San Diego River	8.41	4.81	2.94
Chollas Creek	0.00	0.00	0.00

Similarly, the percent contribution from urbanized sources for each watershed is shown in Table I-4.

Table I-4. Percent Contribution of Bacteria from Urbanized Sources

Watershed	Percent of Existing Fecal Coliform Load	Percent of Existing Total Coliform Load	Percent of Existing Enterococci Load
Laguna/San Joaquin	11.02	20.24	16.03
Aliso Creek	37.11	51.51	45.53
Dana Point	44.32	59.88	51.60
San Juan Creek	8.67	15.33	14.67
San Clemente	17.73	28.21	23.81
San Luis Rey	2.86	6.61	8.00
San Marcos	38.80	71.14	73.49
San Dieguito	3.81	10.66	12.93
Miramar	65.82	81.81	71.51
Scripps	62.93	81.92	75.65
San Diego River	9.61	24.04	21.47
Chollas Creek	55.76	78.42	74.65

Owners and operators of agriculture, livestock, and horse ranch facilities in the San Juan Creek, San Luis Rey River, San Marcos Creek, and San Dieguito River watersheds are given required reductions that are proportional to the existing loads generated by these sources. The LAs for the Ag/Livestock category are calculated as follows:

$$LA(Ag\ /\ Livestock) = [TMDL - WLA(Caltrans) - LA(Open\ Space)] * \left[\frac{X}{Y}\right]$$

where X = % Total Existing Load from Agriculture/Livestock/Horse land uses (Table I-3),
and
Y = % Total Existing Load from Agriculture/Livestock/Horse land uses + % Total Existing Load from Urban land uses (summation of entries from Table I-3 and I-4)

In other words, the wasteload allocations for Caltrans and Open Space, which are equal to the existing loads for these categories and do not require reductions, are subtracted from the TMDL load. That difference ([*TMDL – WLA (Caltrans) – LA(Open Space*]) must be divided between the Ag/Livestock category and Municipal MS4 category. The ratio of the existing Ag/Livestock loading to the existing Municipal MS4 loading (the [X/Y] term in the equation) is the basis for splitting the difference between the two categories.

The variables X and Y are determined from Tables I-3 and I-4, which are in turn derived from the pie charts (Figures I-5 through I-40).

An example calculation for San Juan Creek watershed is shown below. The value for the TMDL is found in Table I-1. The values for the WLA (Caltrans), LA (Open Space) are equal to existing loads and are found in Table I-12. All values are specific to the San Juan Creek watershed.

$$LA\ (Ag/Livestock) = [14{,}714{,}833 - 1{,}541 - 10{,}701{,}109] * \left[\frac{21.4\%}{21.4\% + 8.67\%}\right]$$

$$= 2{,}855{,}361 \text{ billion MPN/year}$$

The percent reduction required for fecal coliform for agriculture, livestock, and horse ranch facilities is

$$Percent\ Reduction = \frac{(Existing\ Load\ From\ Ag/Livestock - LA\ (Ag/Livestock))}{Existing\ Load\ From\ Ag/Livestock}$$

$$= \frac{(3{,}275{,}225\ billion\ MPN\ /\ year - 2{,}855{,}361\ billion\ MPN\ /\ year)}{3{,}275{,}225\ billion\ MPN\ /\ year}$$

$$= 0.128$$
$$= 12.8\%$$

Once WLAs for agriculture, livestock, and horse ranch facilities have been determined, the remaining portion of the TMDL is allocated to Municipal MS4s. The WLAs for Municipal MS4s are given by:

$$WLA(MS4s) = TMDL - WLA(Caltrans) - LA(Ag\,/\,Livestock) - LA(Open\ Space)$$

Using the value for *LA (Ag/Livestock)* calculated in the previous step, *WLA (Municipal MS4s)* can be determined for the San Juan Creek watershed.

WLA (Municipal MS4s) = [14,714,833 – 1,541 – 10,701,109 – 2,856,361] billion MPN/year

= 1,156,822 billion MPN/year

Note that the formula for determining WLAs for Municipal MS4s is the same as the one described in methodology a). An important point is that the difference between the two methodologies is that in watersheds where loads from Ag/Livestock are insignificant, the LAs for this catergory are identical to existing loads. However, in watersheds where loads from Ag/Livestock are significant, the LAs for this category are lower than existing loads.

Table I-5 shows the WLAs, LAs, and percent reductions using interim numeric targets required for the Aliso Creek and San Juan Creek watersheds using the methods outlined in this appendix. The Municipal MS4s and Ag/Livestock categories are required to reduce the bacteria loads in each watershed by the amount specified in Figures I-41 through I-43.

Table I-5. Interim WLAs and LAs (Billion MPN/Year) for Fecal Coliform in the Aliso Creek and San Juan Creek Watersheds

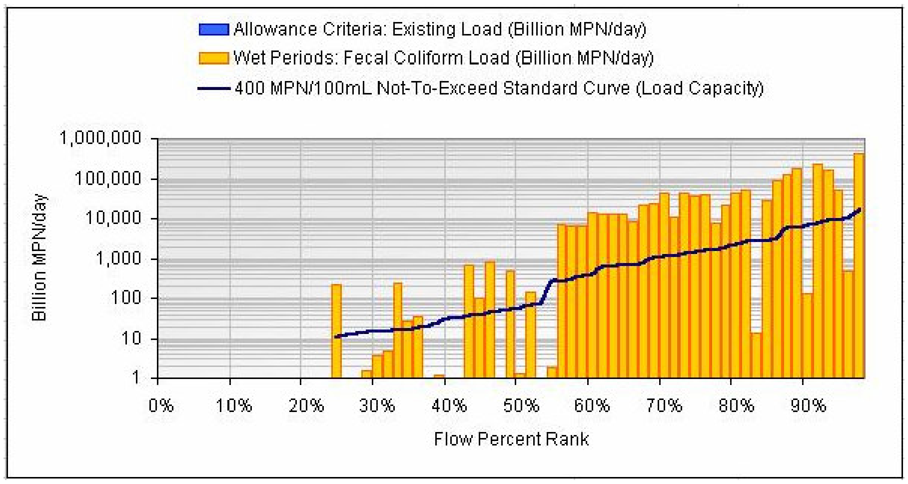
Watershed	TMDL	WLA (Municipal MS4)	% Reduction	WLA (Caltrans)[A]	$\frac{X}{Y}$ [B]	LA (Ag/Livestock)	% Reduction	LA (Open Space)[A]
Aliso Creek	1,579,074	477,264	27	268	0.04	26,457	0	1,075,085
San Juan Creek	14,714,833	1,155,872	13	1,541	0.71	2,856,311	13	10,701,109

[A]No reductions are required for Caltrans or Open Space
[B]X = % Total Existing Load from Agriculture/Livestock/Horse land uses, and
Y = % Total Existing Load from Agriculture/Livestock/Horse land uses
+ % Total Existing Load from Urban land uses

The information in Table I-5 (except for the values for X and Y) is available for the remaining watersheds, and for total coliform and enterococci, and is reported in Tables 9-1, 9-4, and 9-8 in section 9 of the Technical Report.

I.5 Calculation of TMDLs Using Final Numeric Targets for Wet Weather Analysis

The methodology for calculating TMDLs and allocations using final numeric targets is similar to the methodology for calculating allowable loads using interim numeric targets. The difference is that with final numeric targets, there is no application of the reference system approach, and therefore, no allowable exceedance loads. Figure I-4 shows the load-duration curve for fecal coliform for the Aliso Creek watershed, using the final numeric targets.



Fecal Coliform Loading Summary	Value	Units
Total Load for Existing Condition (Total Load)	1,732,709	Billion MPN/Year
Non-allowable Exceedance Load (Exceedance Load)	1,648,711	Billion MPN/Year
Allowable Load = (Total Load - Exceedance Load)	83,999	Billion MPN/Year
Percent Reduction Required from Existing Condition	**95.2%**	**Percentage**

Figure I-4. Load Duration Curve for Aliso Creek Subwatershed #202 (No Reference System Approach)

Inspection of Figures I-2 and I-4 reveal that the only difference in the graphs is that there are no allowable exceedance loads identified by blue bars. In contrast to the discussion in section I.4, all the loads in Figure I-4 with magnitudes above the numeric target line, are considered exceedance loads and must be reduced. The TMDL is now only the sum of the bars below the numeric target line.

Because the methodologies for calculating interim and final TMDLs and allocations are identical, the steps outlined in section I.4 are applicable to section I.5 and therefore not repeated. The steps shown below contain only results that differ from section I.4.

1. Quantify Existing Bacteria Loads and TMDLs

As with interim numeric targets, the loads from the entire watershed are derived from loads calculated from each subwatershed. In this case, the loads for Aliso Creek are derived from the load-duration curves representing subwatersheds 201 and 202. Using values from load duration curves describing fecal coliform in Aliso Creek (Tables P-16 and P-19 in Appendix P),

Total Load = (Total Load)$_{\text{Subwatershed 201}}$ + (Total Load)$_{\text{Subwatershed 202}}$
= 19,386 billion MPN/year + 1,732,709 billion MPN/year
= 1,752,095 billion MPN/year

TMDL = (Allowable Load)$_{\text{Subwatershed 201}}$ + (Allowable Load)$_{\text{Subwatershed 202}}$
= 563 billion MPN/year + 83,999 billion MPN/year

= 84,562 billion MPN/year

TMDL calculations in all watersheds using final numeric targets are lower than TMDLs calculated using interim numeric targets. Final TMDLs for all watersheds are shown in Table I-6.

Table I-6. Final Wet Weather TMDLs (Billion MPN/Year)

Watershed	Fecal Coliform TMDLs	Total Coliform TMDLs	Enterococci TMDLs
Laguna/San Joaquin	16,042	9,238	4,175
Aliso Creek	84,562	57,629	13,704
Dana Point	14,894	8,387	3,875
San Juan Creek	358,410	8,947,114	56,119
San Clemente	36,481	20,998	9,492
San Luis Rey River	641,823	440,347	174,221
San Marcos	1,559	899	406
San Dieguito River	431,004	461,886	133,530
Miramar	312	182	81
Scripps	10,329	5,940	2,686
San Diego River	311,132	189,650	48,356
Chollas Creek	55,516	1,386,037	9,073

2. <u>Calculate Percent Reduction Required Per Discharge Category</u>

Comparing the final wet weather TMDLs to the loads from the uncontrollable sources (from the previous analysis) show that, in every watershed, the loads from uncontrollable sources are greater than the TMDL. This indicates that the natural bacteria sources in the watersheds consume and exceed the assimilative capacity of the receiving waters, resulting in allocations of zero loads to all remaining sources, namely controllable point and nonpoint sources.

For Municipal MS4s, the percent reduction required for the Aliso Creek watershed is:

$$\text{Percent Reduction} = \frac{(649{,}935 \text{ billion MPN/mL} - 0 \text{ MPN/mL})}{649{,}935 \text{ billion MPN/mL}}$$

$$\begin{aligned}\text{Percent Reduction} &= 1 \\ &= 100\%\end{aligned}$$

Similarly, for agriculture, livestock, and horse ranch facilities in the San Juan watershed,

$$\text{Percent Reduction} = \frac{(3{,}275{,}225 \text{ billion MPN/mL} - 0 \text{ MPN/mL})}{3{,}275{,}225 \text{ billion MPN/mL}}$$

$$\begin{aligned}\text{Percent Reduction} &= 1 \\ &= 100\%\end{aligned}$$

In order to meet the final numeric targets, the required reduction for each indicator bacteria from all controllable sources in all watersheds is 100 percent.

Table I-7 shows the WLAs, LAs, and percent reductions using final numeric targets for the Aliso and San Juan watersheds using the methods outlined in this appendix. This information is available for the remaining watersheds and is reported in Tables 9-2, 9-5, and 9-9 in section 9 of the Technical Report.

Table I-7. Final Wet Weather WLAs and LAs (Billion MPN/Year) for Fecal Coliform in the Aliso Creek and San Juan Creek Watersheds

Watershed	TMDL	WLA (Municipal MS4)	% Reduction	WLA (Caltrans)	% Reduction	LA (Ag/Livestock)	% Reduction	LA (Open Space)*
Aliso Creek	84,562	0	100	0	100	0	100	1,075,085
San Juan Creek	358,410	0	100	0	100	0	100	10,701,109

* No bacteria load reductions are required from Open Space category because allocations are equal to existing loads.

I.6 Calculation of TMDLs Using Interim and Final Numeric Targets for Dry Weather Analysis

Because the density of bacteria in receiving waters during dry weather is extremely variable in nature, a separate approach from the wet weather LSPC model was needed. An approach was developed that relied on detailed analysis of available data to better identify and characterize sources.

To represent the linkage between source contributions and in-stream response, a steady-state mass balance model was developed to simulate transport of bacteria in the impaired creeks and the creeks flowing to impaired shorelines. This predictive model represents the streams as a series of plug-flow reactors, with each reactor having a constant, steady state flow and bacteria load. The development of the dry weather model is described in Appendix K.

For the dry weather model, interim and final numeric targets were used to calculate TMDLs, although in a different capacity than interim and final numeric targets for wet weather TMDLs. Step 1 shows how numeric targets were used, and step 2 shows how TMDLs were allocated.

1. <u>Use of Interim and Final Numeric Targets</u>

Unlike the wet weather model, the dry weather model does not use the reference system approach. This is because available data show that exceedances of WQOs in local reference systems during dry weather conditions are uncommon (see Technical Report, section 4.2). Furthermore, reference systems do not generate significant dry weather bacteria loads because flows are minimal. During dry weather, flow, and hence bacteria loads, are largely generated by urban runoff, which is not a product of a reference system.

Therefore interim numeric targets for dry weather to incorporate a reference system are unnecessary.

Interim and final numeric targets were utilized in a different capacity from the wet weather analysis. Interim and final numeric targets were utilized for total coliform, for protection of REC-1 and SHELL beneficial uses, respectively. Interim allowable loads were calculated using the REC-1 WQOs as numeric targets. Final allowable loads for total coliform were calculated using numeric targets equal to the more stringent SHELL WQOs because WQOs for SHELL are more stringent than WQOs for REC-1. To calculate the TMDL, model predicted flow was multiplied by the applicable numeric target. Tables I-8 and I-9 show interim and final dry weather TMDLs for all watersheds.

Table I-8. Interim Dry Weather TMDLs (Billion MPN/Month)

Watershed	Fecal Coliform TMDLs	Total Coliform TMDLs	Enterococci TMDLs
Laguna/San Joaquin	227	1,134	41
Aliso Creek	242	1,208	40
Dana Point	92	462	16
San Juan Creek	1,665	8,342	275
San Clemente	192	958	33
San Luis Rey River	1,058	5,289	185
San Marcos	26	129	5
San Dieguito River	1,293	6,468	226
Miramar	7	36	1
Scripps	119	594	21
San Diego River	1,506	7,529	248
Chollas Creek	398	1,991	66

Table I-9. Final Dry Weather TMDLs (Billion MPN/Month)

Watershed	Fecal Coliform TMDLs	Total Coliform TMDLs	Enterococci TMDLs
Laguna/San Joaquin	227	79	41
Aliso Creek	242	85	40
Dana Point	92	32	16
San Juan Creek	1,665	8,324	275
San Clemente	192	67	33
San Luis Rey River	1,058	370	185
San Marcos	26	9	5
San Dieguito River	1,293	453	226
Miramar	7	3	1
Scripps	119	42	21
San Diego River	1,506	527	248
Chollas Creek	398	1,991	66

2. TMDL Allocation

Unlike wet weather loading, which is caused by rain events, dry weather analysis showed that dry weather loading is dominated by nuisance flows from urban land use activities such as car washing, sidewalk washing, and lawn over-irrigation, which pick up and transport bacteria into receiving waters. These types of nuisance flows are referred to as urban runoff.

Because urban runoff is overwhelmingly the main source of bacteria loading during dry weather, the TMDLs calculated from the mass balance model were allocated solely to Municipal MS4s. Allocations for nonpoint sources were unnecessary since land uses associated with these sources generally do not generate runoff to receiving water during dry weather conditions. Additionally, dry weather loads from Caltrans highways were assumed to be insignificant because during dry periods there is no significant urban runoff from Caltrans owned roadway surfaces. In other words, dry weather discharges from any sources other than Municipal MS4s is prohibited. Dry weather TMDLs are expressed on a monthly basis (MPN/month) because the numeric targets are equal to the 30-day geometric mean WQOs, and the dry weather model simulates average flows.

An example showing the total coliform TMDL allocation is shown using the Aliso Creek watershed as an example. Total coliform is used in this example because it is the only indicator that has a WQO for SHELL, thereby resulting in different values for the TMDL for the interim and final period.

For the Aliso Creek watershed, the existing total coliform load estimated by the model was approximately 26,639 billion MPN/month. The percent reduction required and the allocations are shown for the interim and final period in Tables I-10 and I-11, respectively.

*Table I-10. Dry Weather **Interim** WLAs and LAs (Billion MPN/Month) for Total Coliform in the Aliso Creek Watershed*

Watershed	TMDL	WLA (Municipal MS4s)	% Reduction	WLA (Caltrans)	LA (Ag/Livestock)	LA (Open Space)
Aliso Creek	1,208	1,208	95.9	0	0	0

*Table I-11. Dry Weather **Final** WLAs and LAs (Billion MPN/Month) for Total Coliform in the Aliso Creek Watershed*

Watershed	TMDL	WLA (Municipal MS4s)	% Reduction	WLA (Caltrans)	LA (Ag/Livestock)	LA (Open Space)
Aliso Creek	85	85	99.7	0	0	0

Similar information for the remaining watersheds is reported in Tables 9-3, 9-7 and 9-10 in section 9 of the Technical Report.

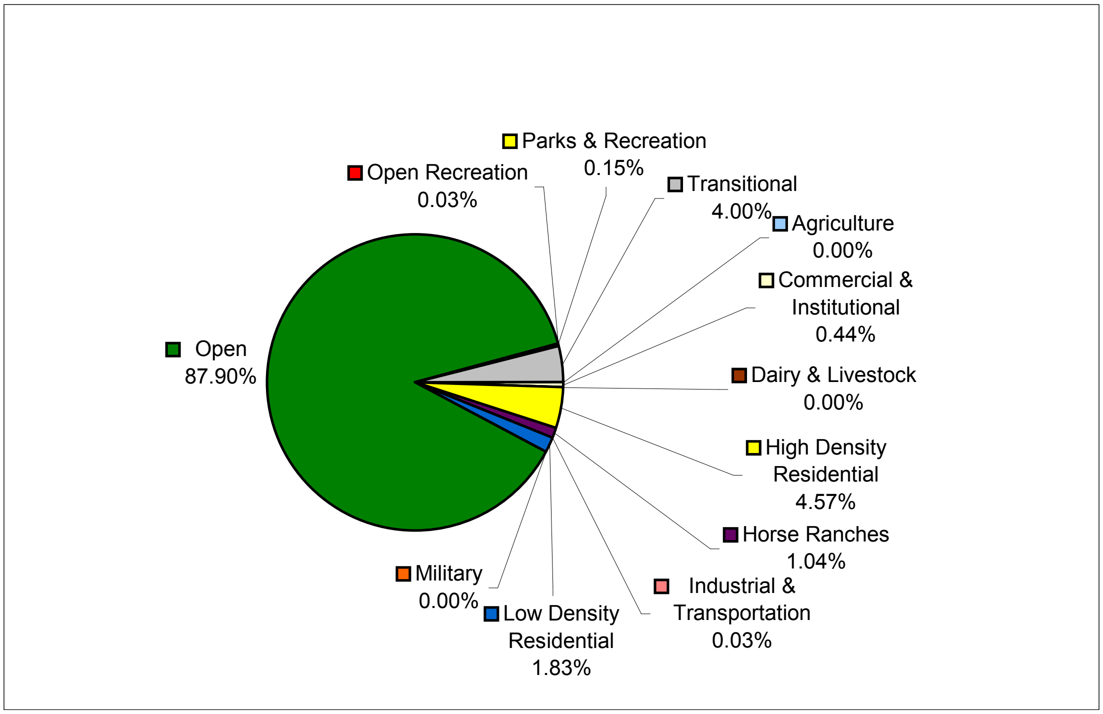


Figure I-5. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Joaquin Hills/Laguna Beach Watershed

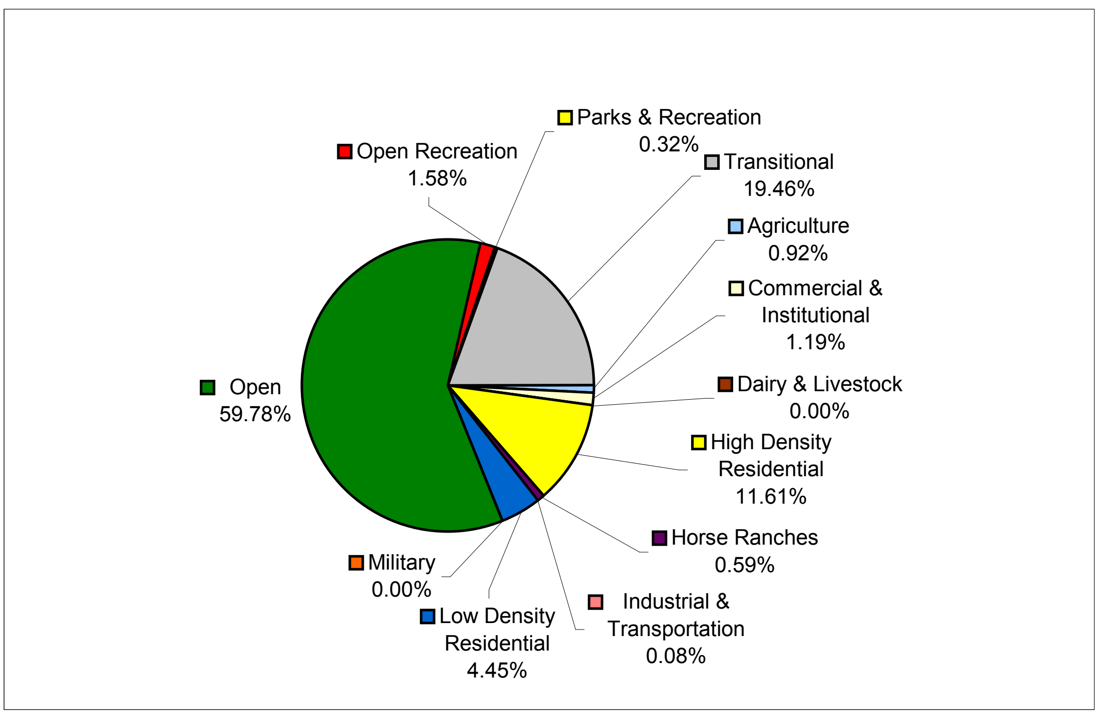


Figure I-6. Percent of Fecal Coliform Load Generated by Different Land Uses in the Aliso Watershed

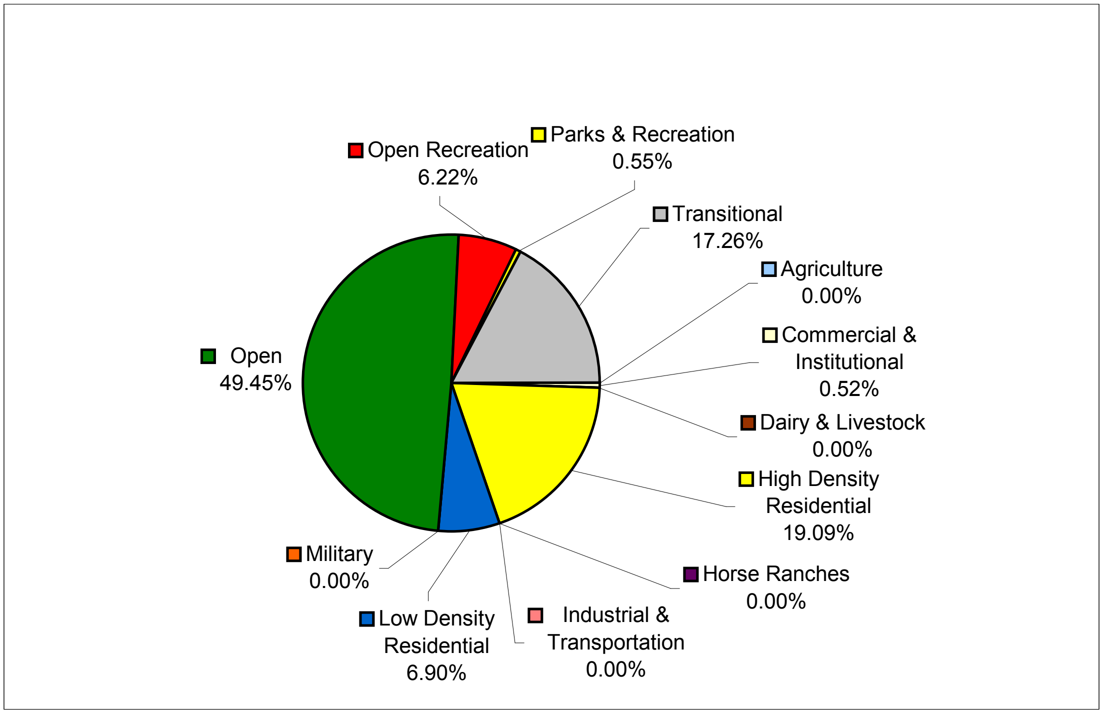


Figure I-7. Percent of Fecal Coliform Load Generated by Different Land Uses in the Dana Point Watershed

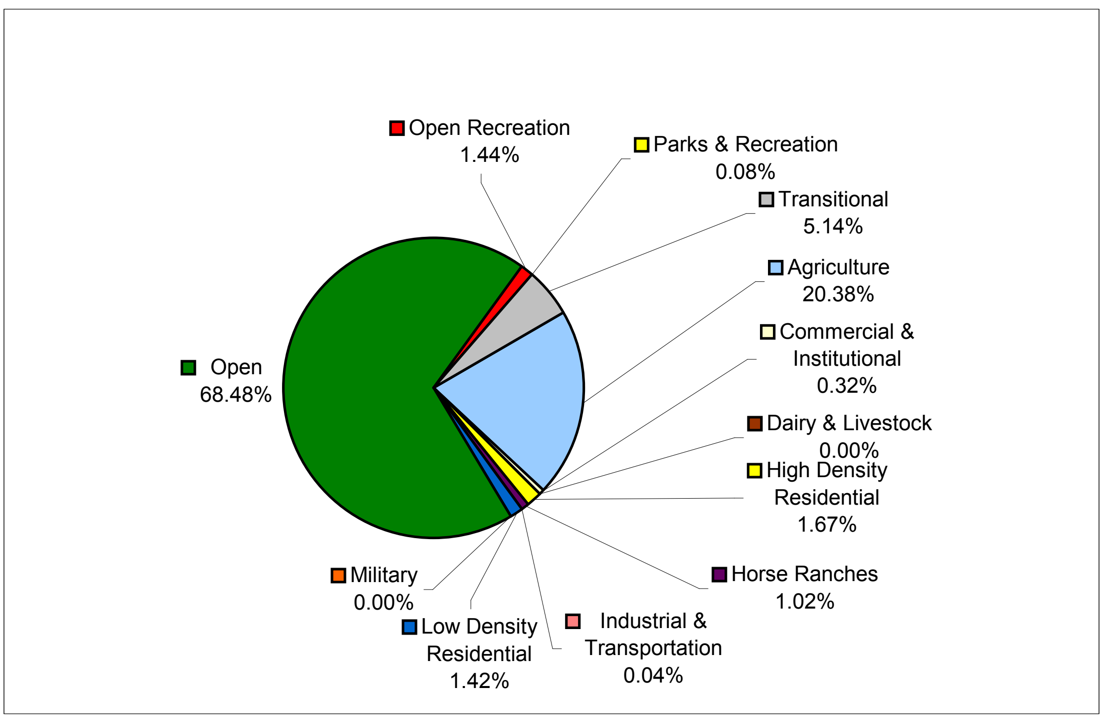


Figure I-8. Percent of Fecal Coliform Load Generated by Different Land Uses in the Lower San Juan Watershed

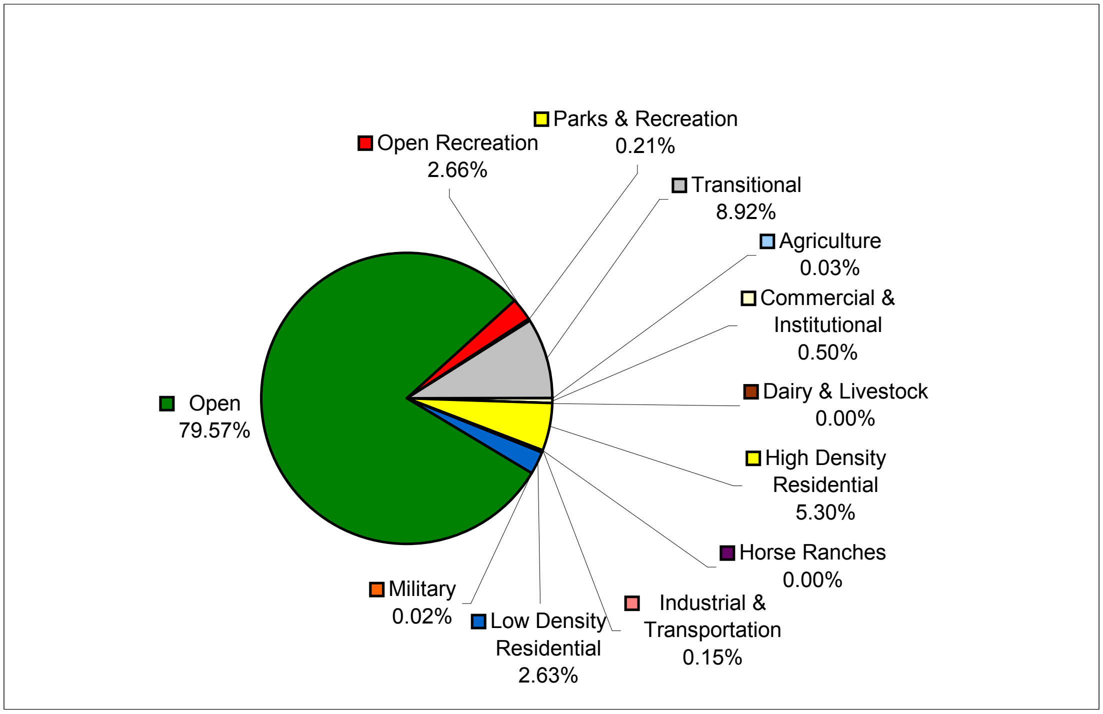


Figure I-9. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Clemente Watershed

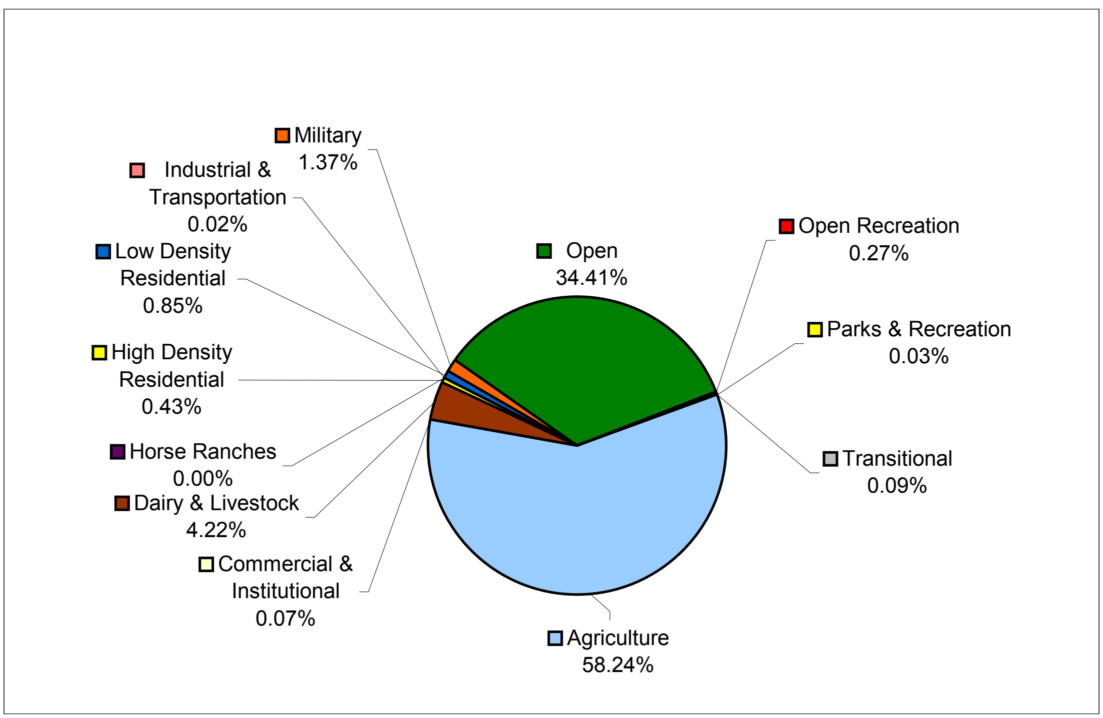


Figure I-10. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Luis Rey Watershed

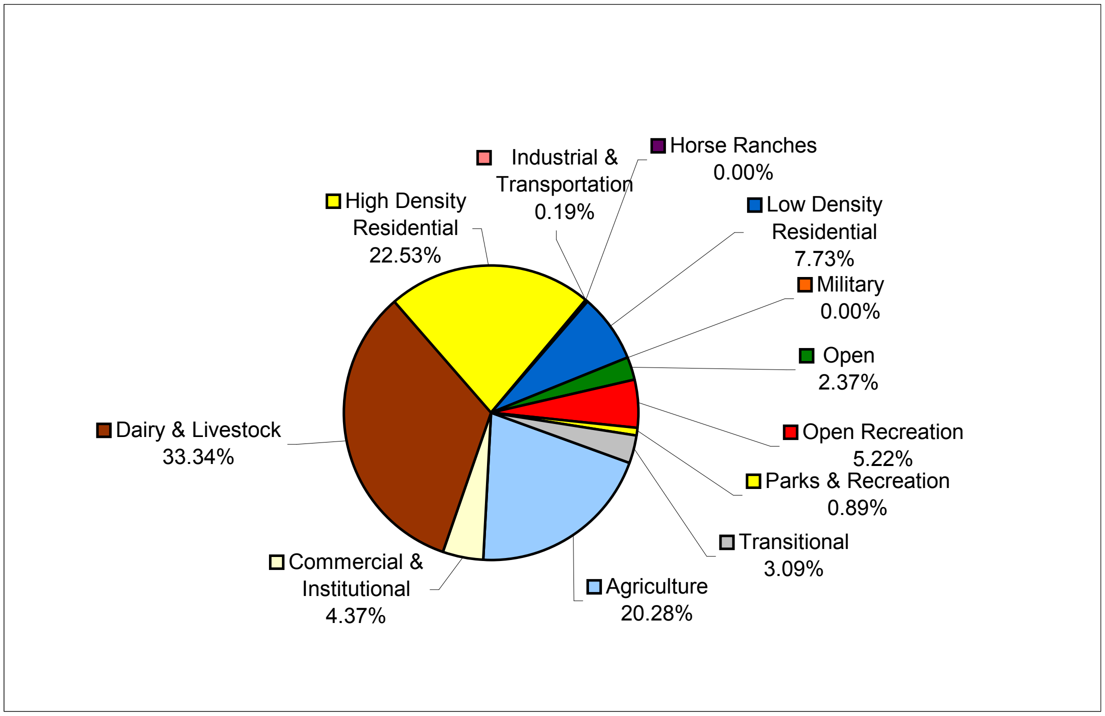


Figure I-11. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Marcos Watershed

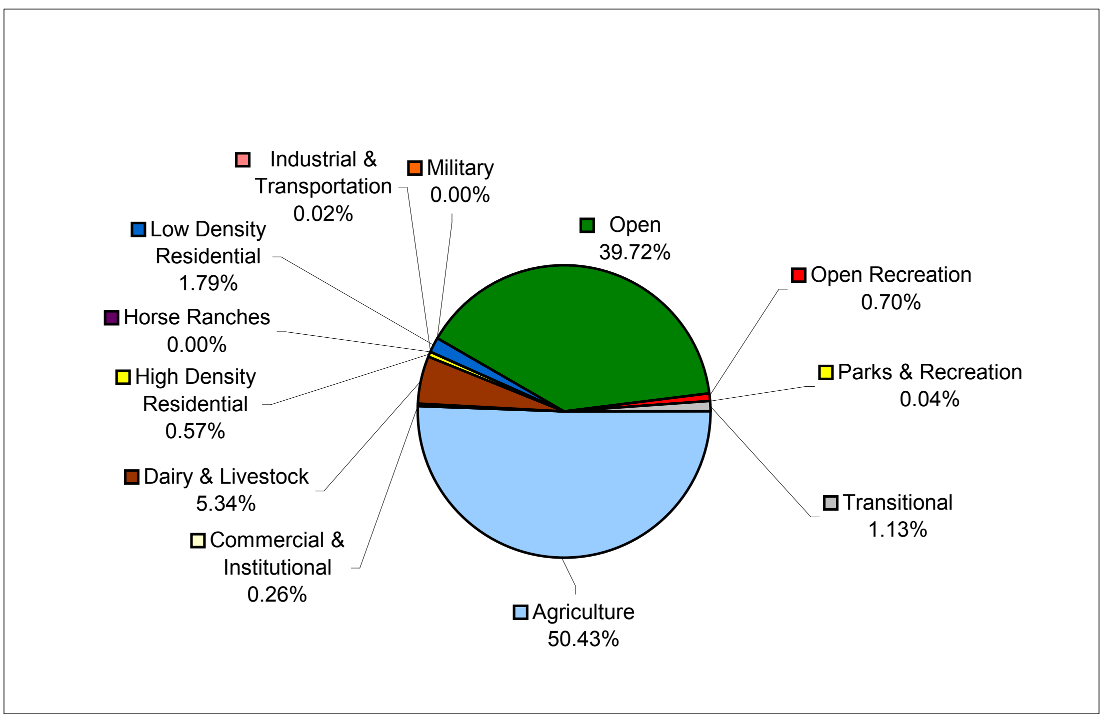


Figure I-12. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Dieguito Watershed

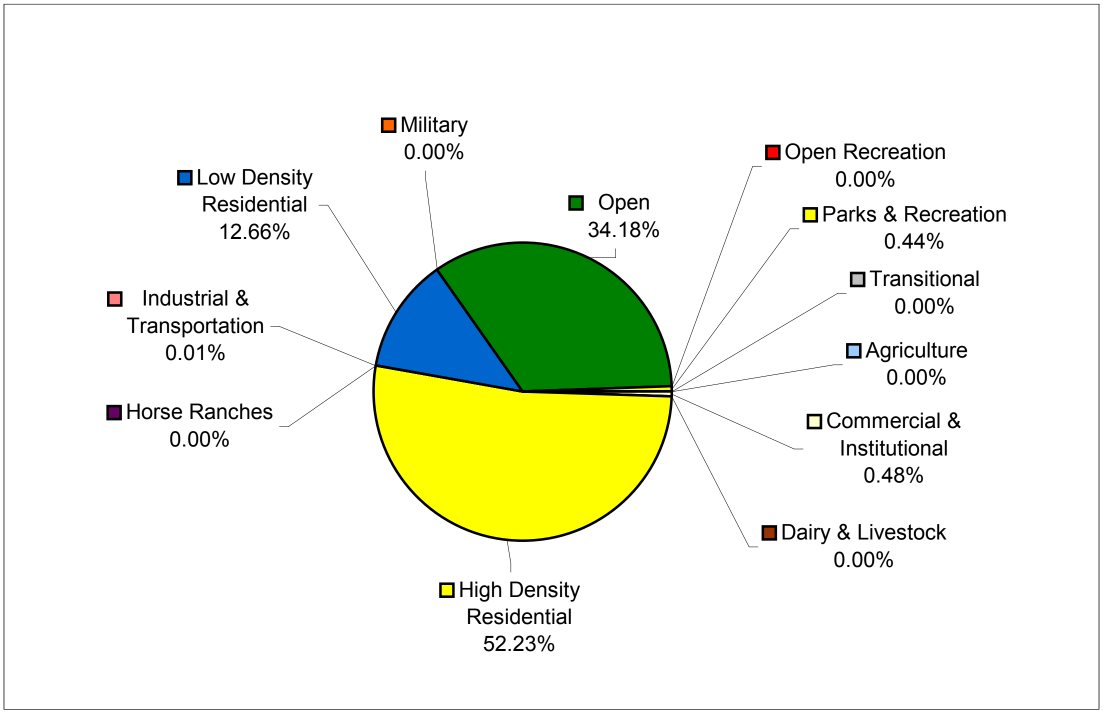


Figure I-13. Percent of Fecal Coliform Load Generated by Different Land Uses in the Miramar Watershed

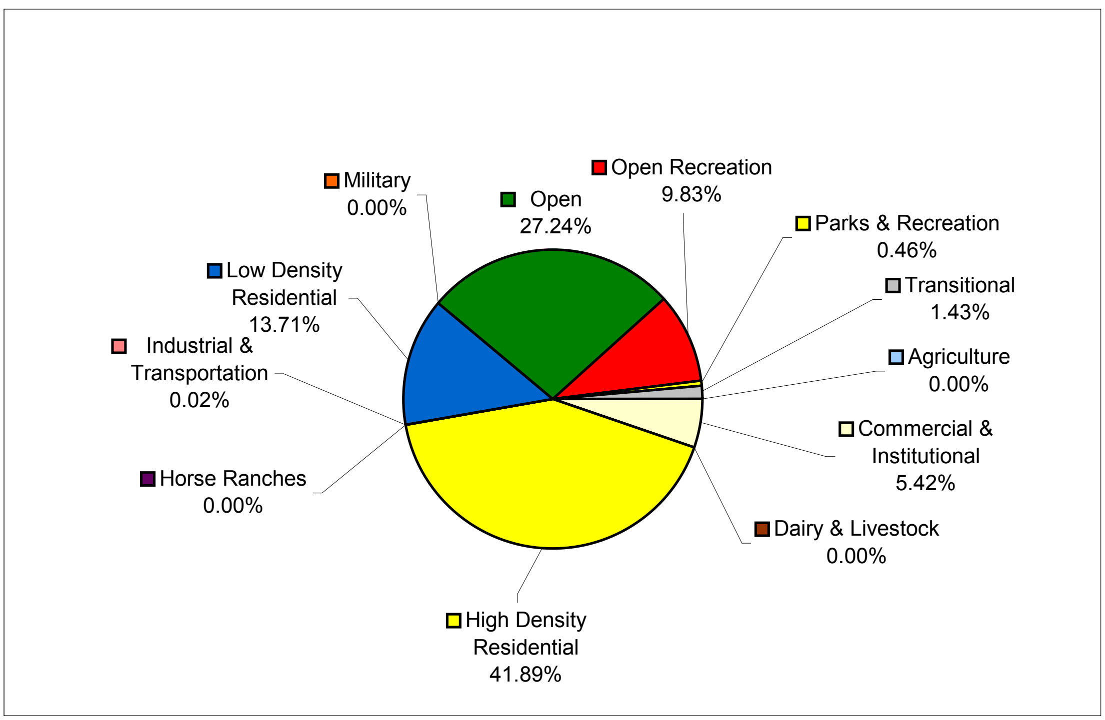


Figure I-14. Percent of Fecal Coliform Load Generated by Different Land Uses in the Scripps Watershed

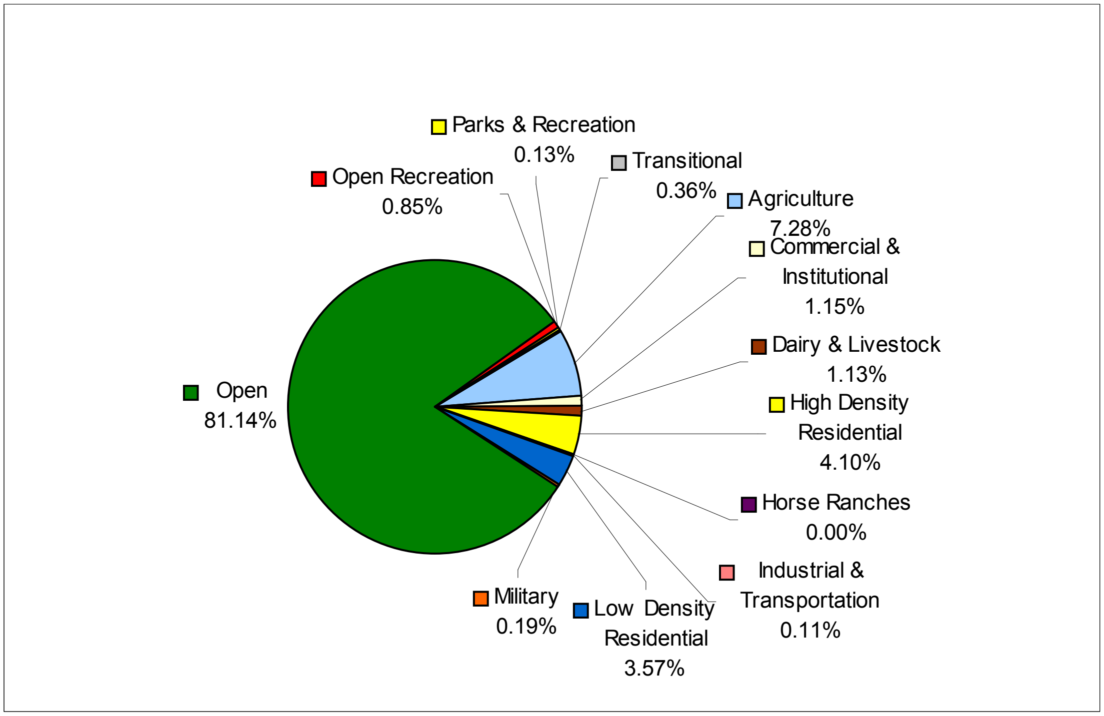


Figure I-15. Percent of Fecal Coliform Load Generated by Different Land Uses in the San Diego River Watershed

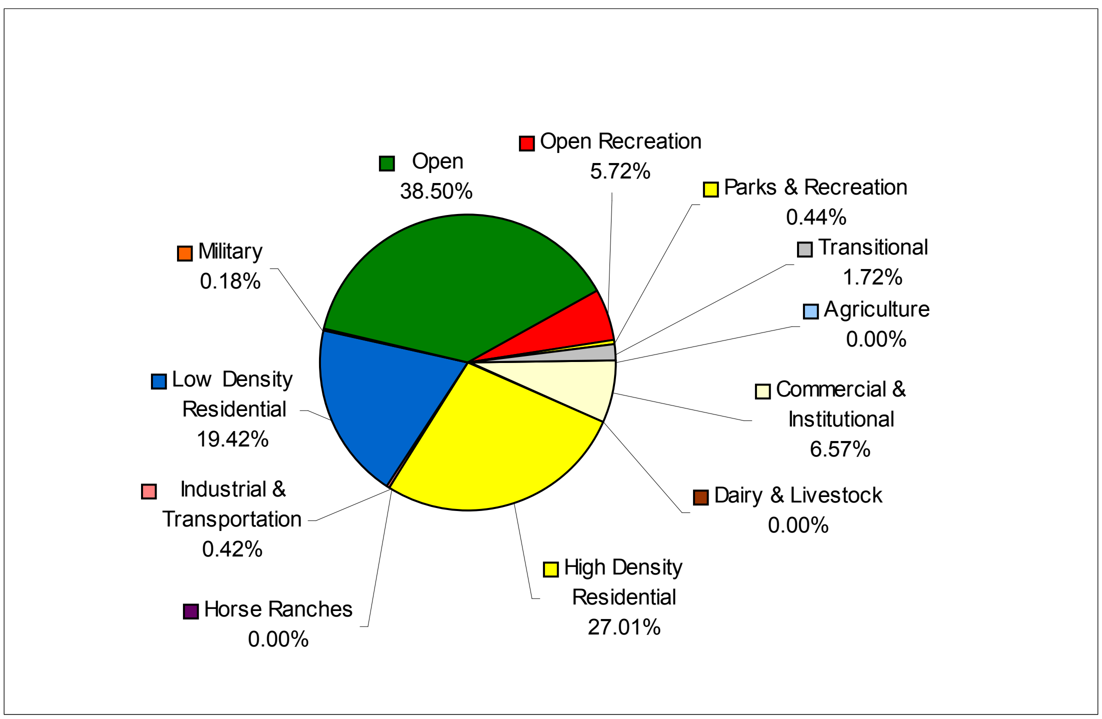


Figure I-16. Percent of Fecal Coliform Load Generated by Different Land Uses in the Chollas Watershed

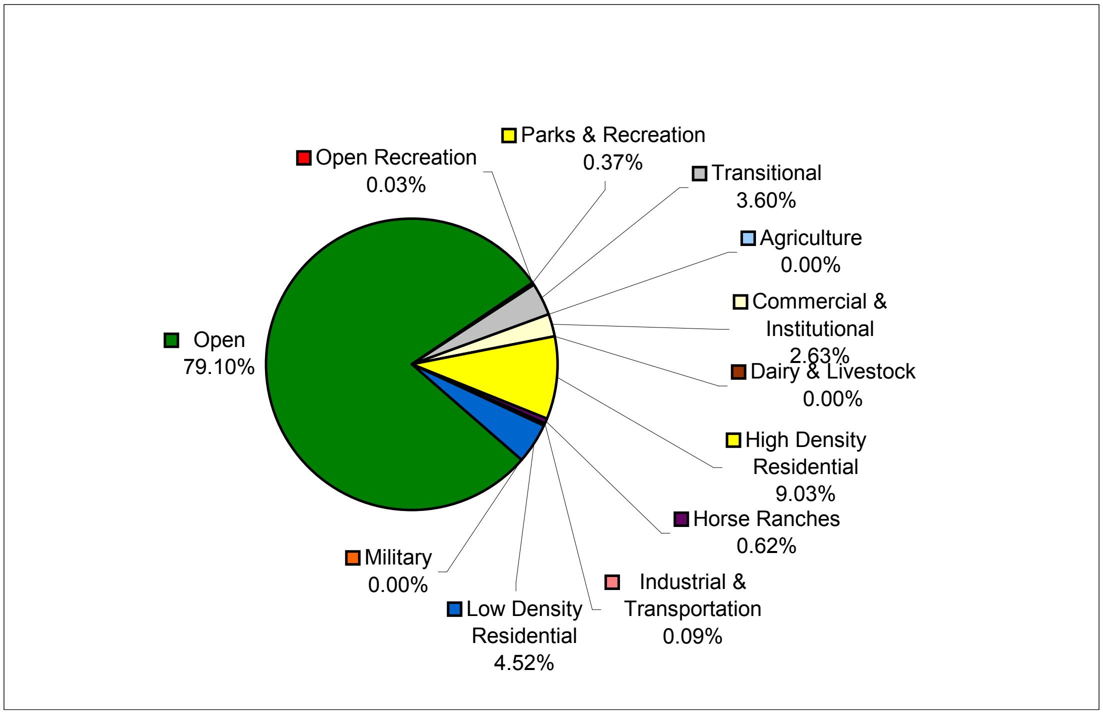


Figure I-17. Percent of Total Coliform Load Generated by Different Land Uses in the San Joaquin Hills/Laguna Beach Watershed

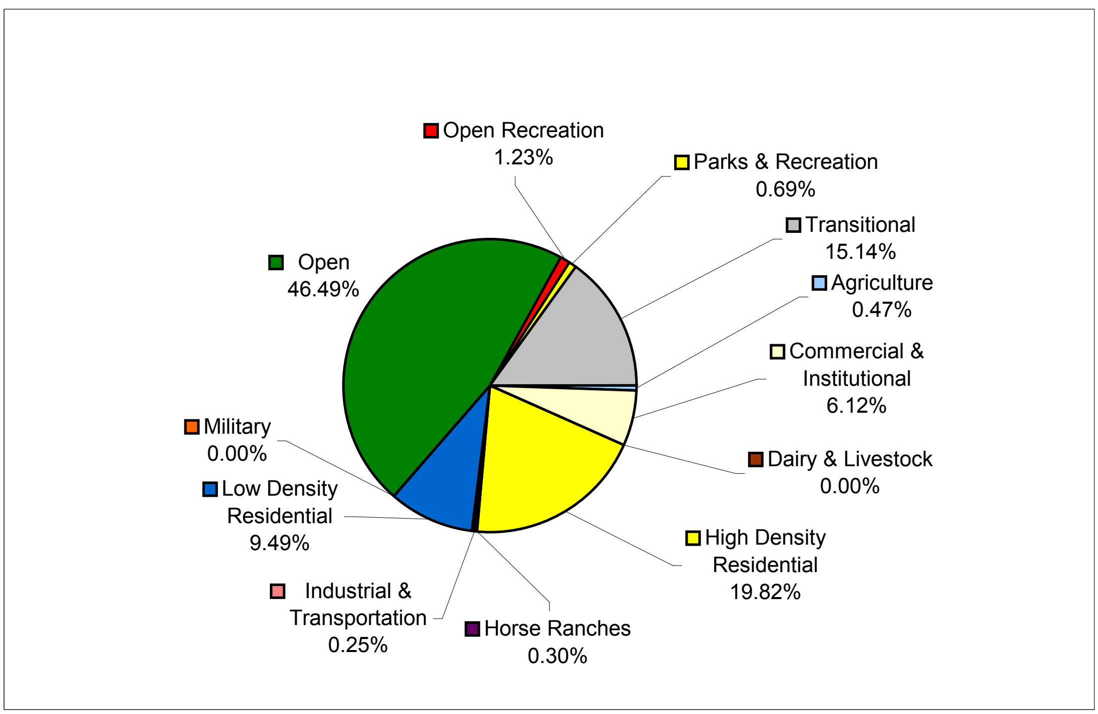


Figure I-18. Percent of Total Coliform Load Generated by Different Land Uses in the Aliso Watershed

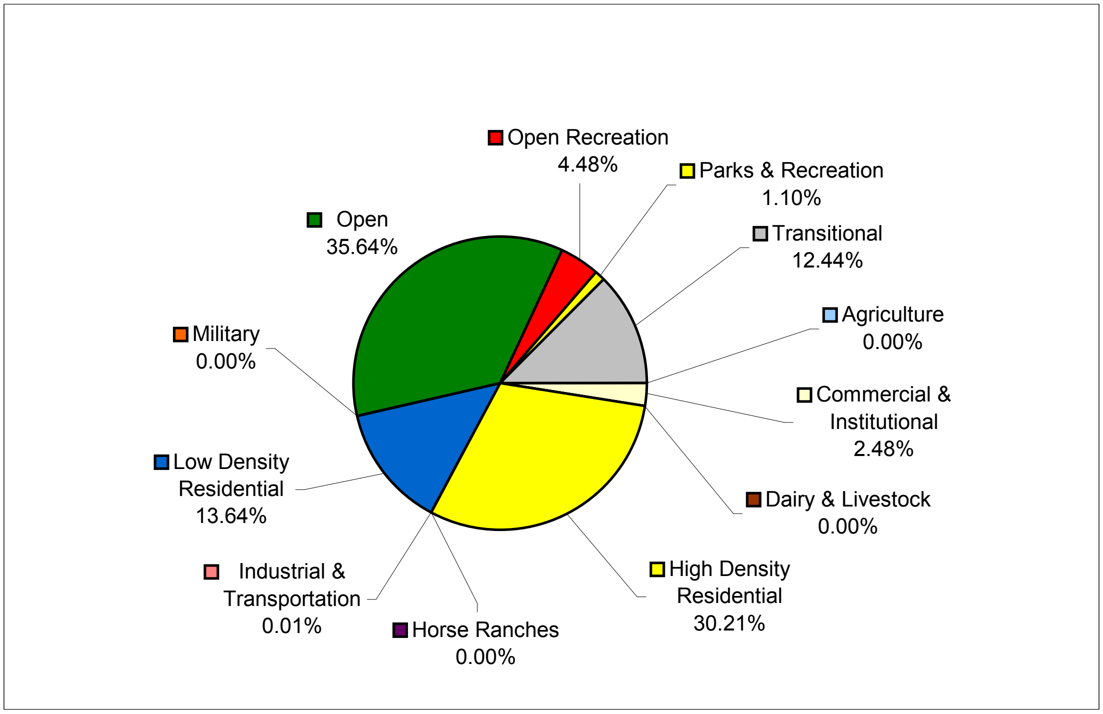


Figure I-19. Percent of Total Coliform Load Generated by Different Land Uses in the Dana Point Watershed

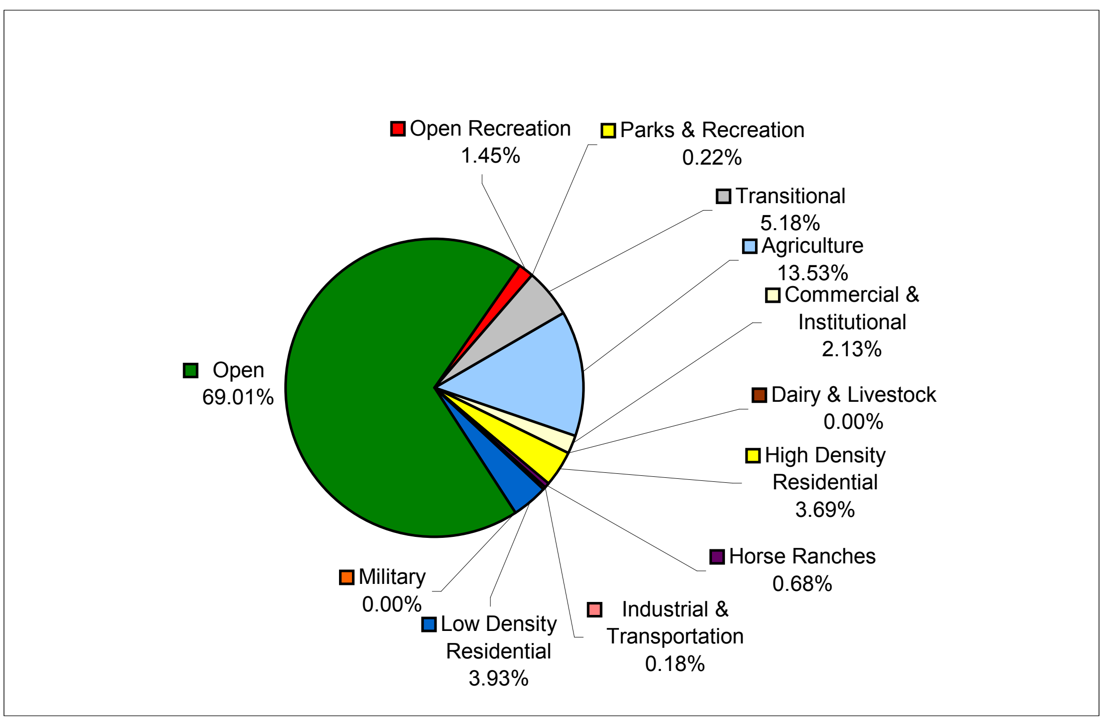


Figure I-20. Percent of Total Coliform Load Generated by Different Land Uses in the Lower San Juan Watershed

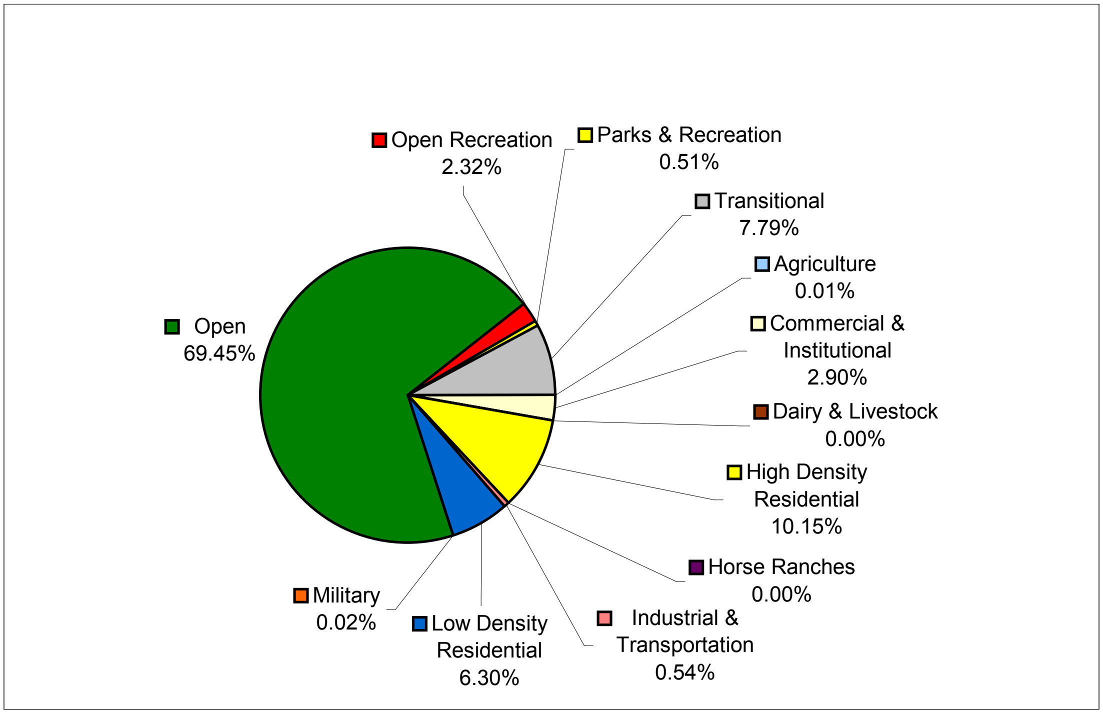


Figure I-21. Percent of Total Coliform Load Generated by Different Land Uses in the San Clemente Watershed

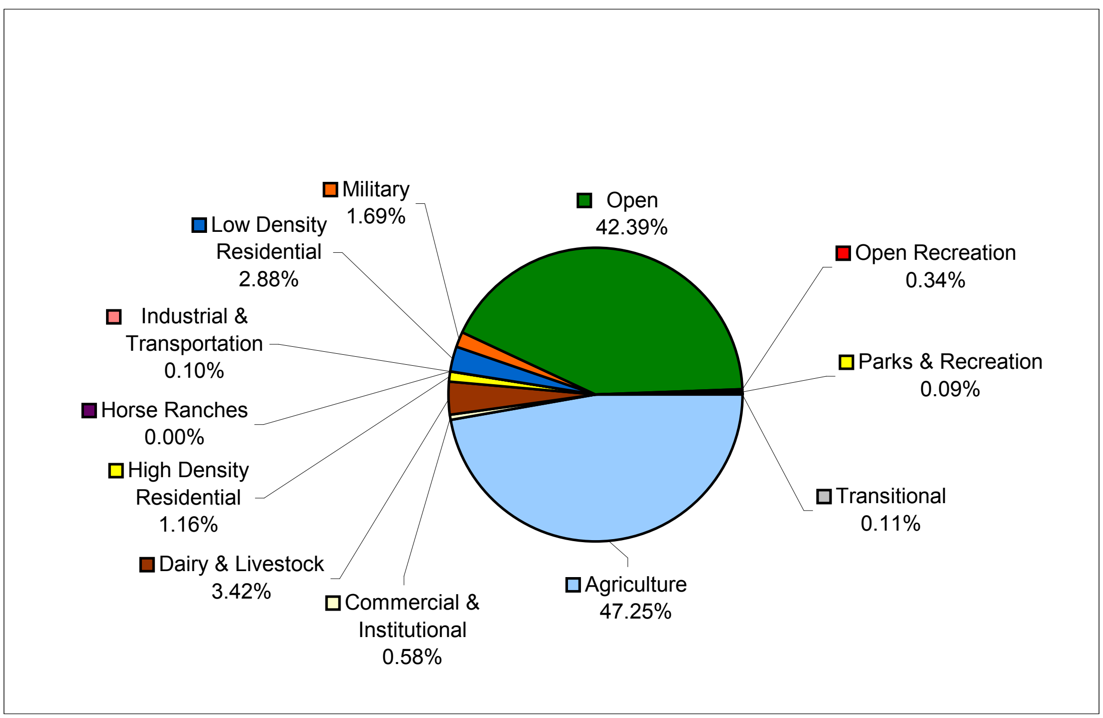


Figure I-22. Percent of Total Coliform Load Generated by Different Land Uses in the San Luis Rey Watershed

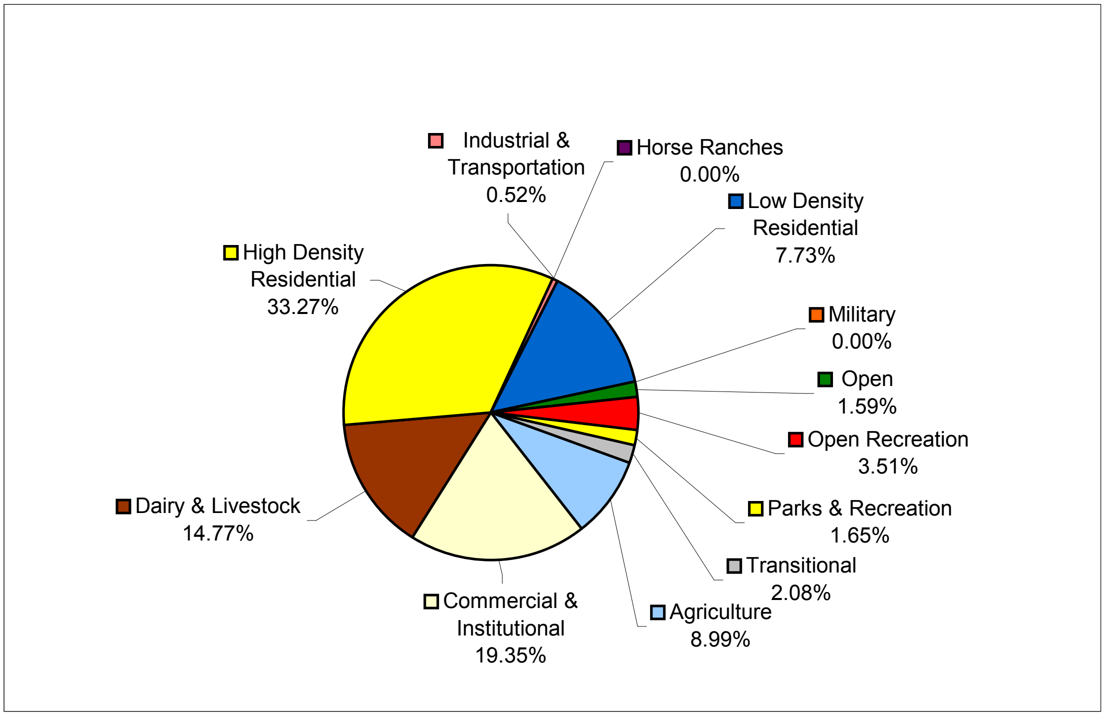


Figure I-23. Percent of Total Coliform Load Generated by Different Land Uses in the San Marcos Watershed

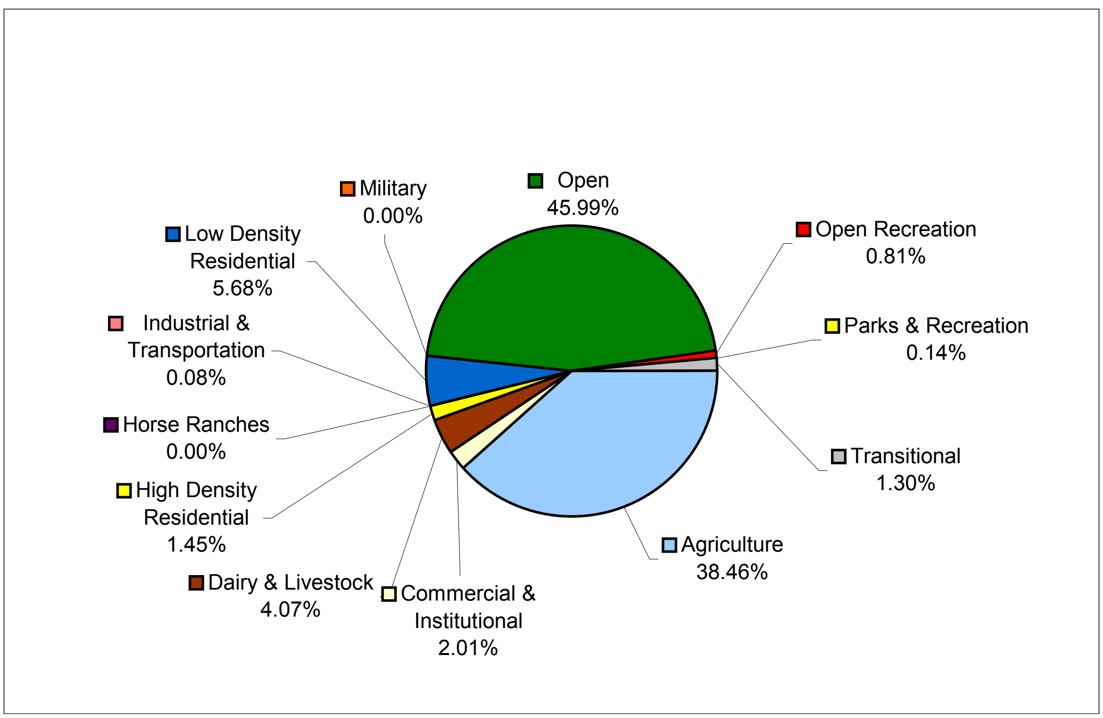


Figure I-24. Percent of Total Coliform Load Generated by Different Land Uses in the San Dieguito Watershed

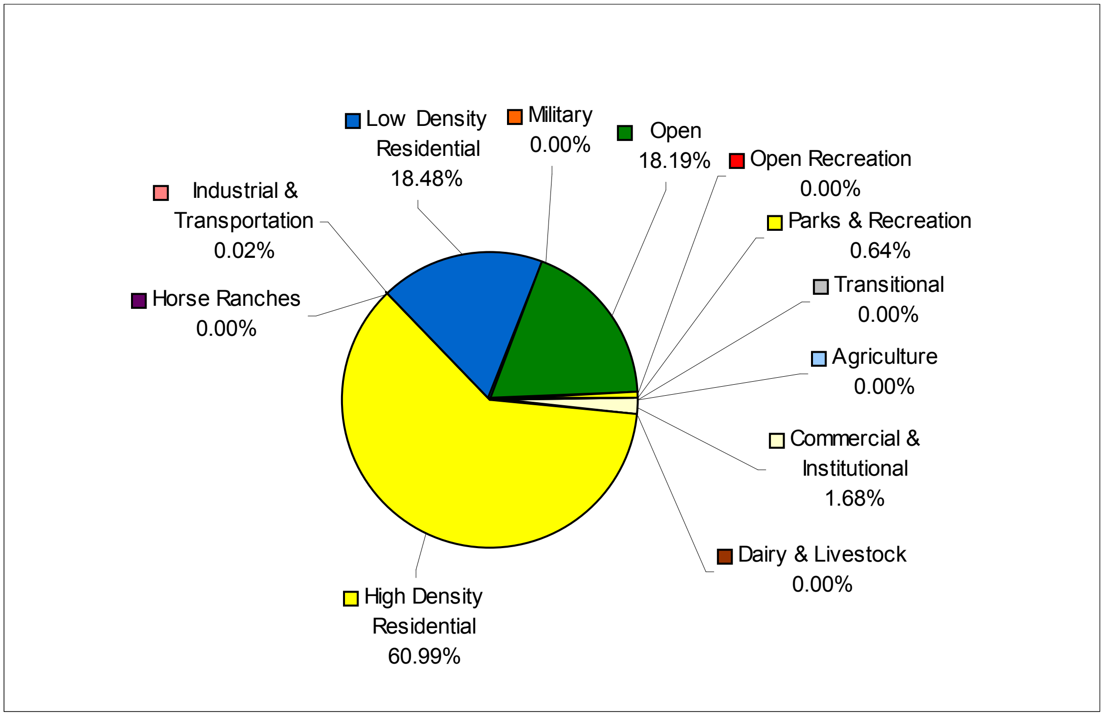


Figure I-25. Percent of Total Coliform Load Generated by Different Land Uses in the Miramar Watershed

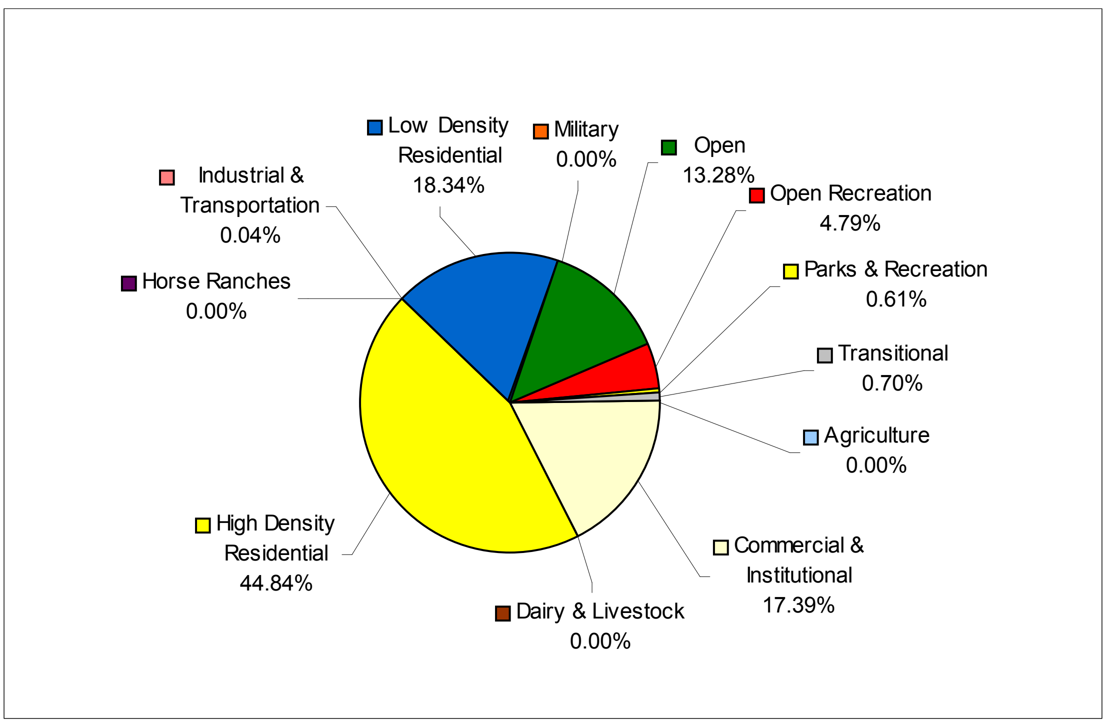


Figure I-26. Percent of Total Coliform Load Generated by Different Land Uses in the Scripps Watershed

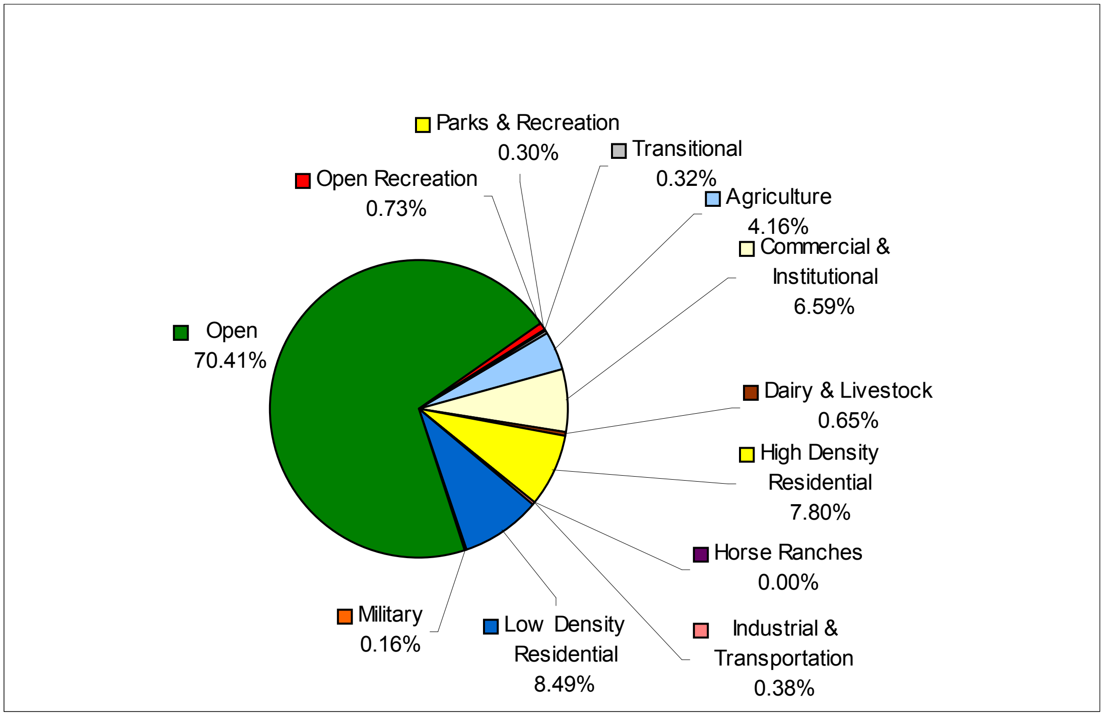


Figure I-27. Percent of Total Coliform Load Generated by Different Land Uses in the San Diego River Watershed

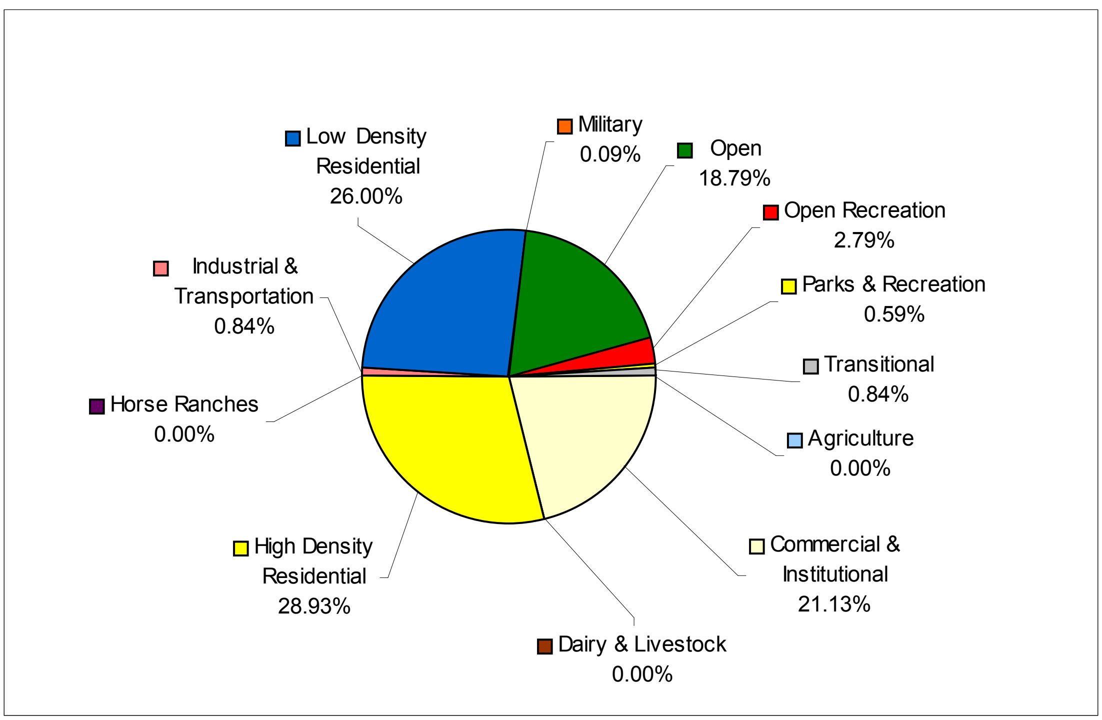


Figure I-28. Percent of Total Coliform Load Generated by Different Land Uses in the Chollas Watershed

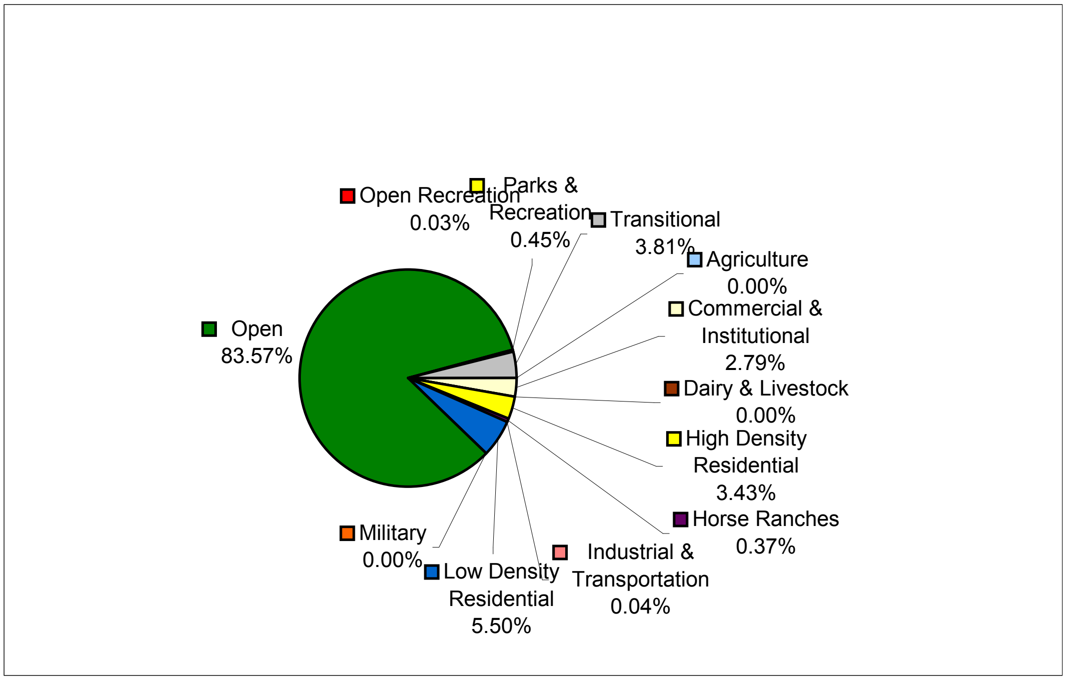


Figure I-29. Percent of Enterococci Load Generated by Different Land Uses in the San Joaquin Hills/Laguna Beach Watershed

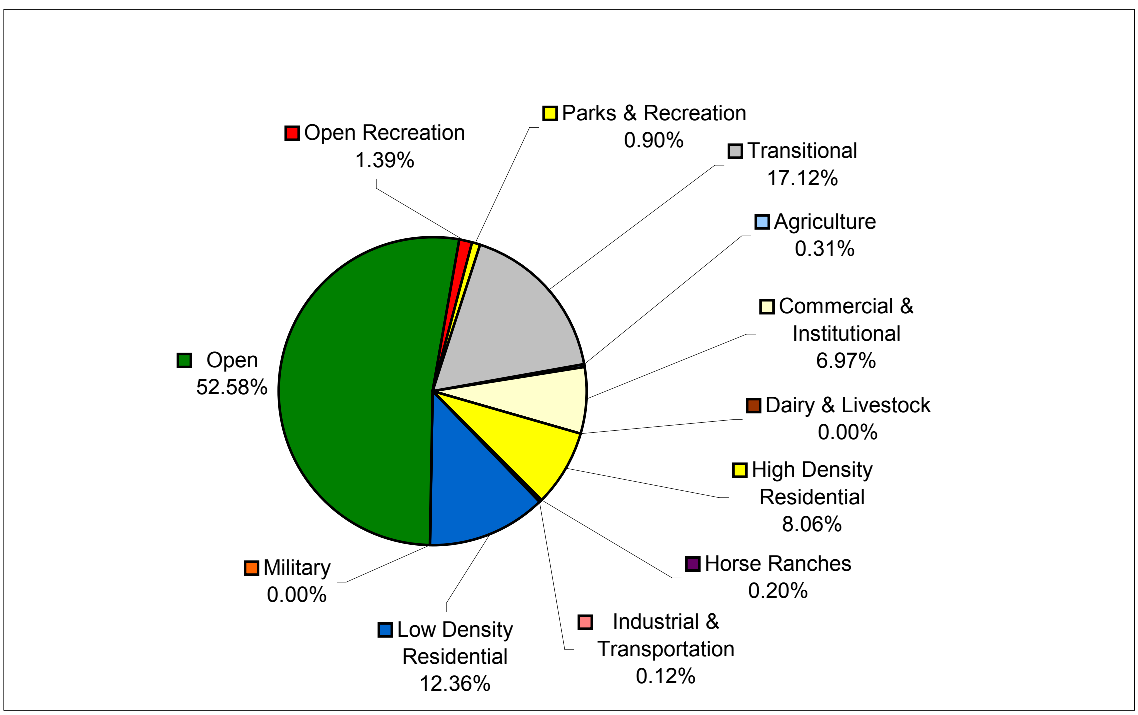


Figure I-30. Percent of Enterococci Load Generated by Different Land Uses in the Aliso Watershed

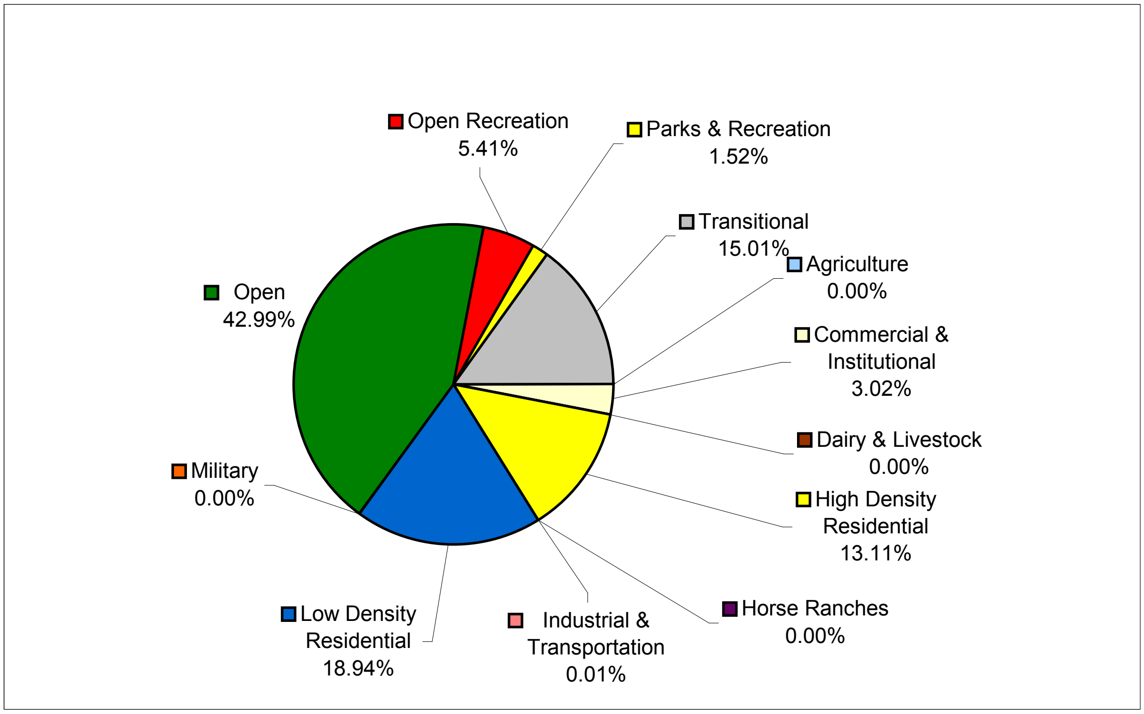


Figure I-31. Percent of Enterococci Load Generated by Different Land Uses in the Dana Point Watershed

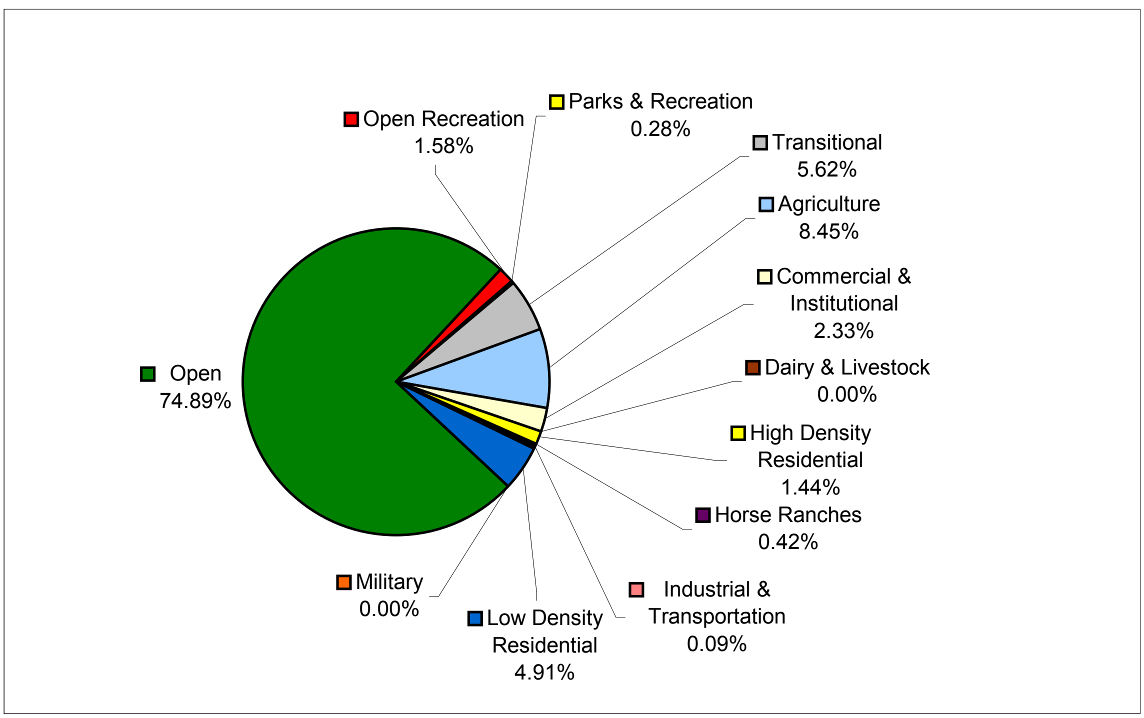


Figure I-32. Percent of Enterococci Load Generated by Different Land Uses in the Lower San Juan Watershed

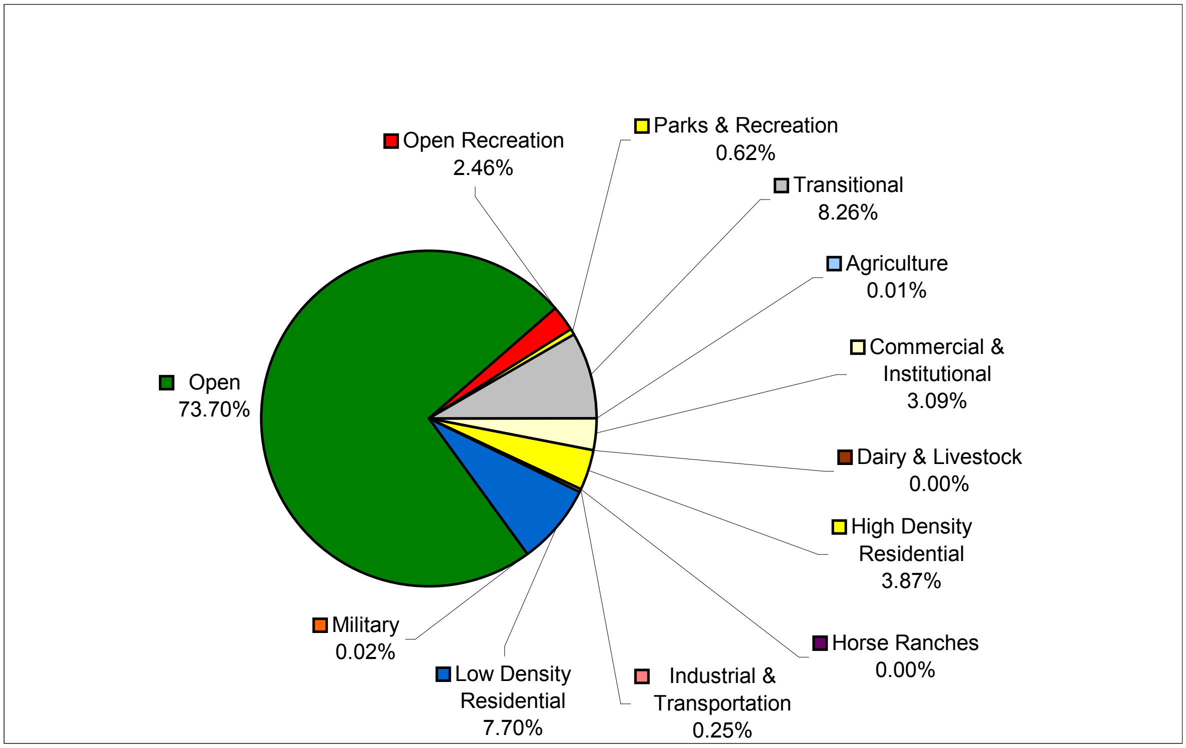


Figure I-33. Percent of Enterococci Load Generated by Different Land Uses in the San Clemente Watershed

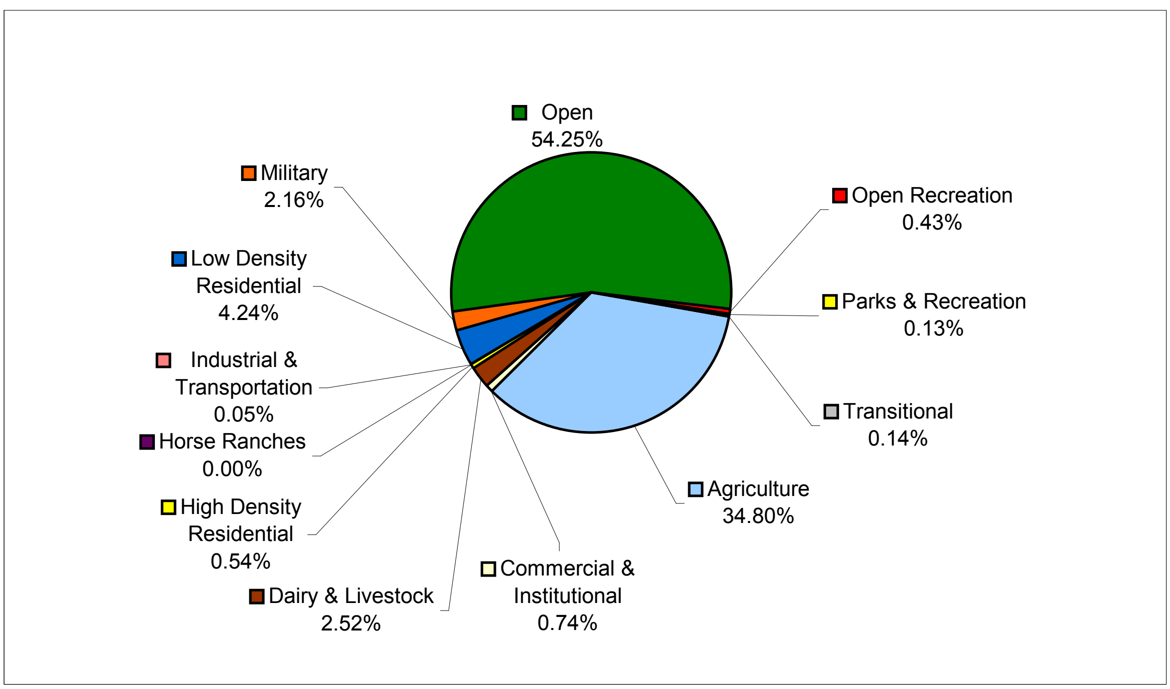


Figure I-34. Percent of Enterococci Load Generated by Different Land Uses in the San Luis Rey Watershed

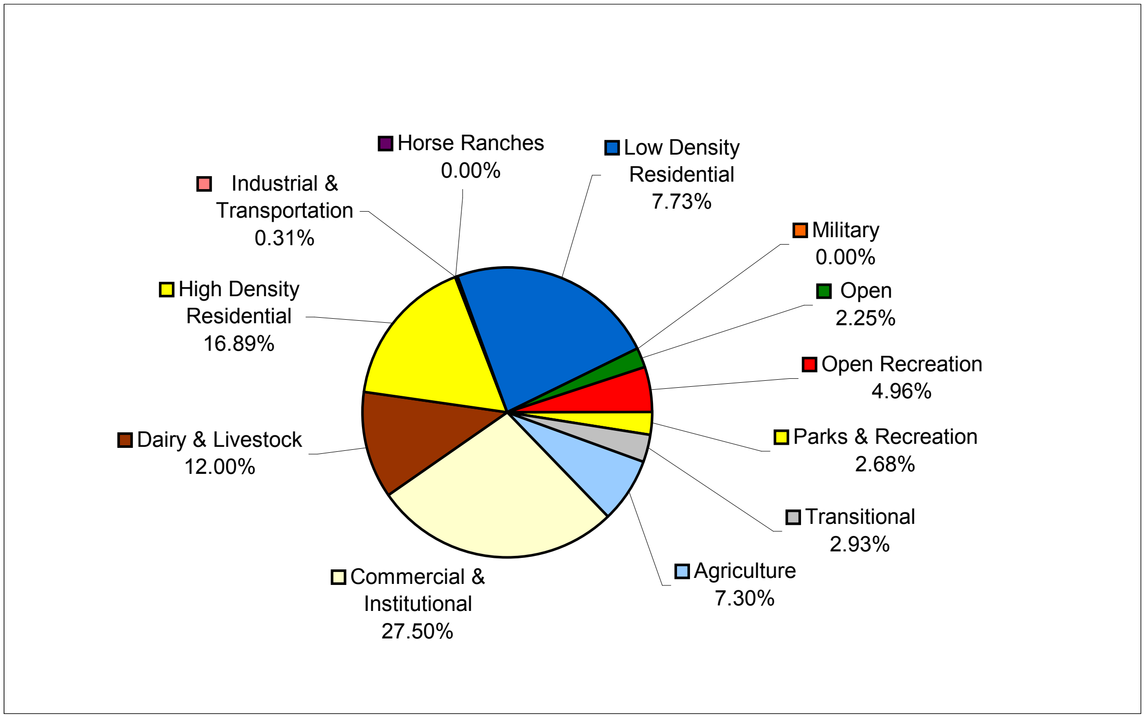


Figure I-35. Percent of Enterococci Load Generated by Different Land Uses in the San Marcos Watershed

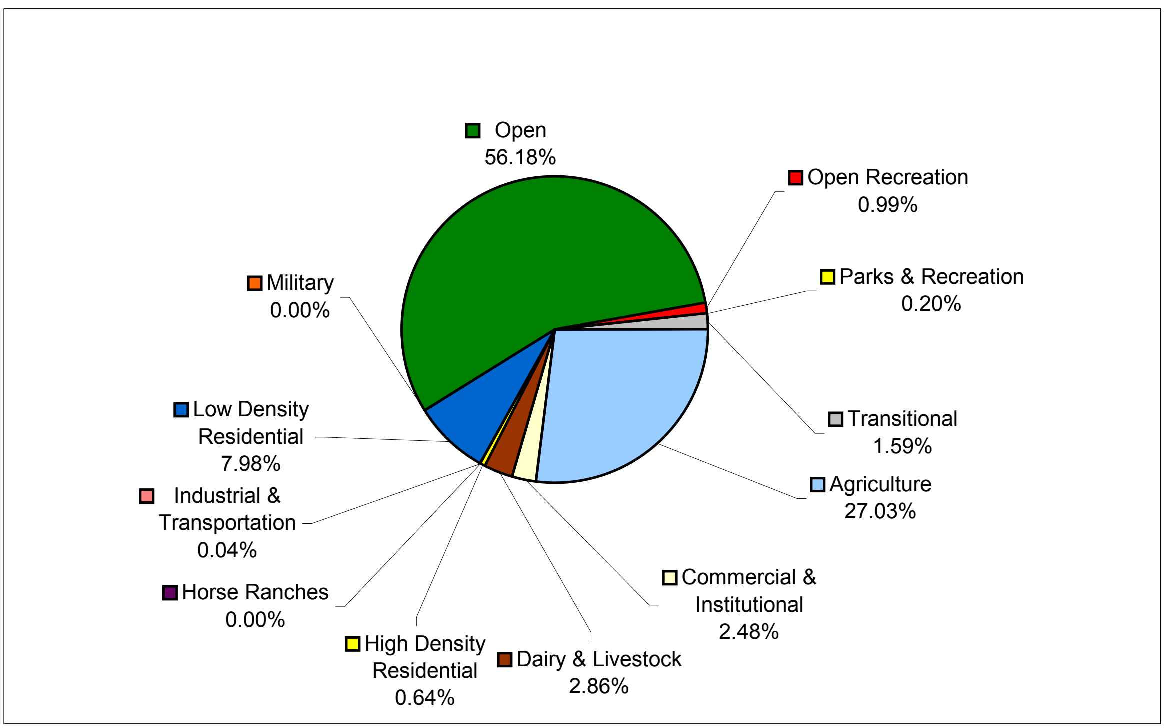


Figure I-36. Percent of Enterococci Load Generated by Different Land Uses in the San Dieguito Watershed

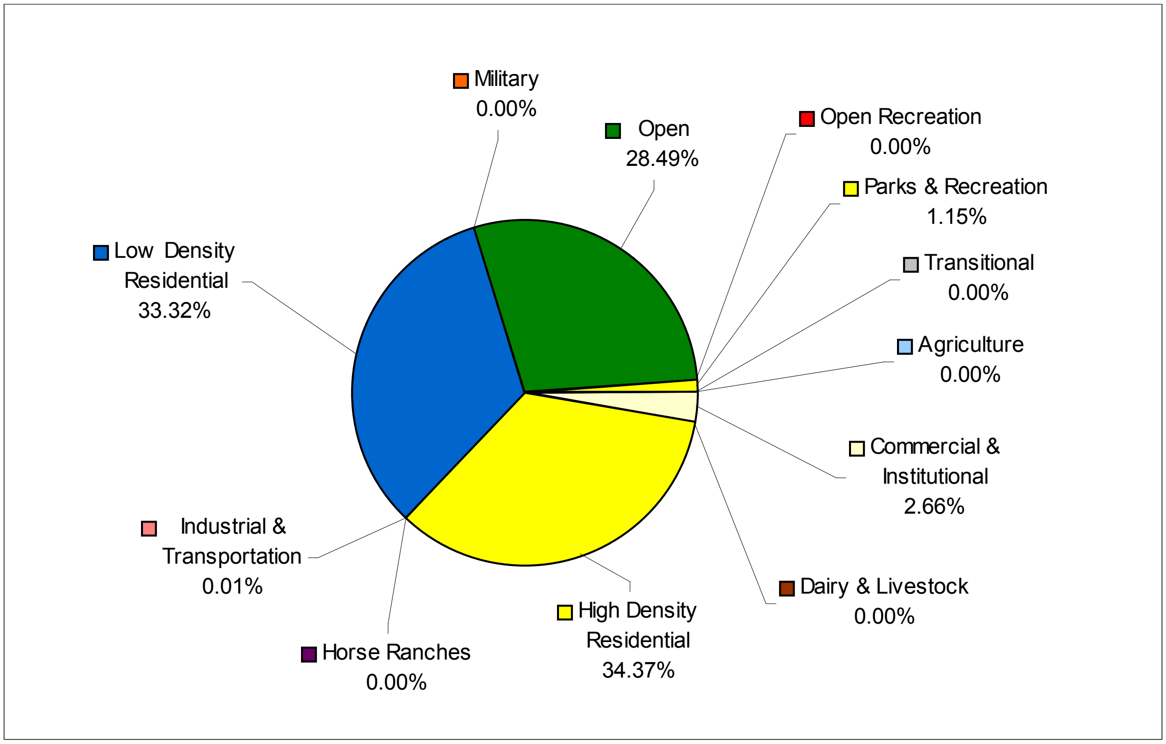


Figure I-37. Percent of Enterococci Load Generated by Different Land Uses in the Miramar Watershed

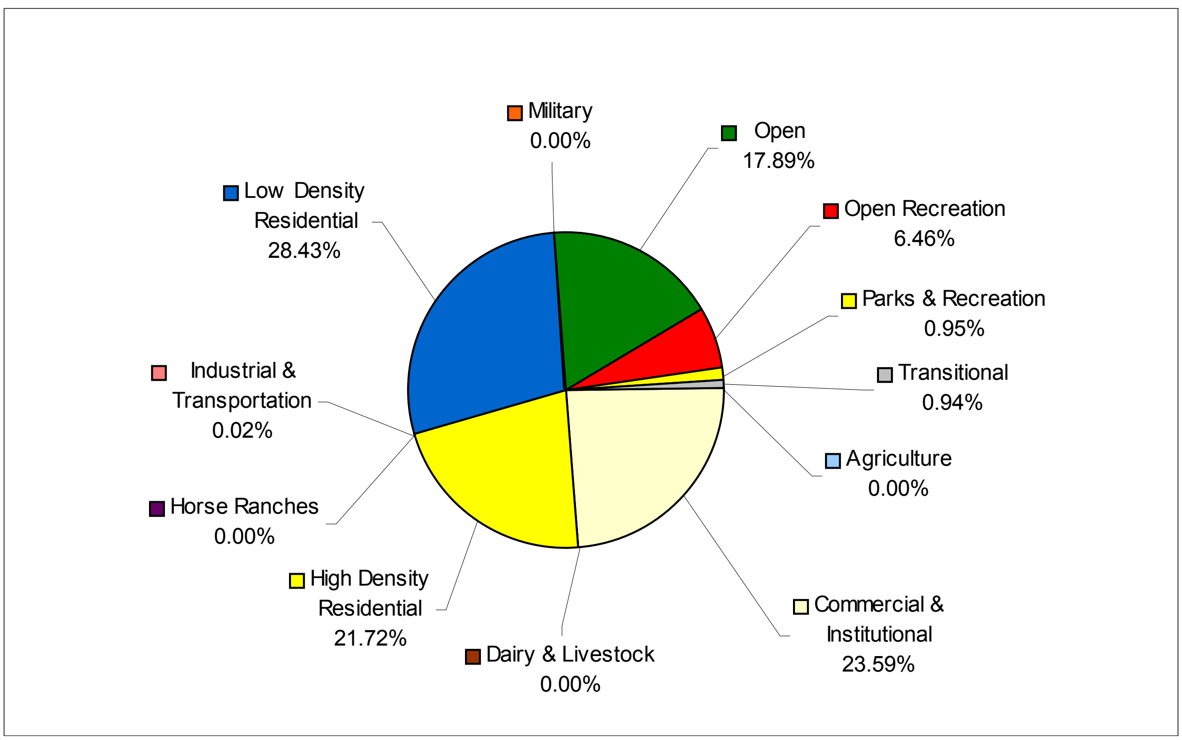


Figure I-38. Percent of Enterococci Load Generated by Different Land Uses in the Scripps Watershed

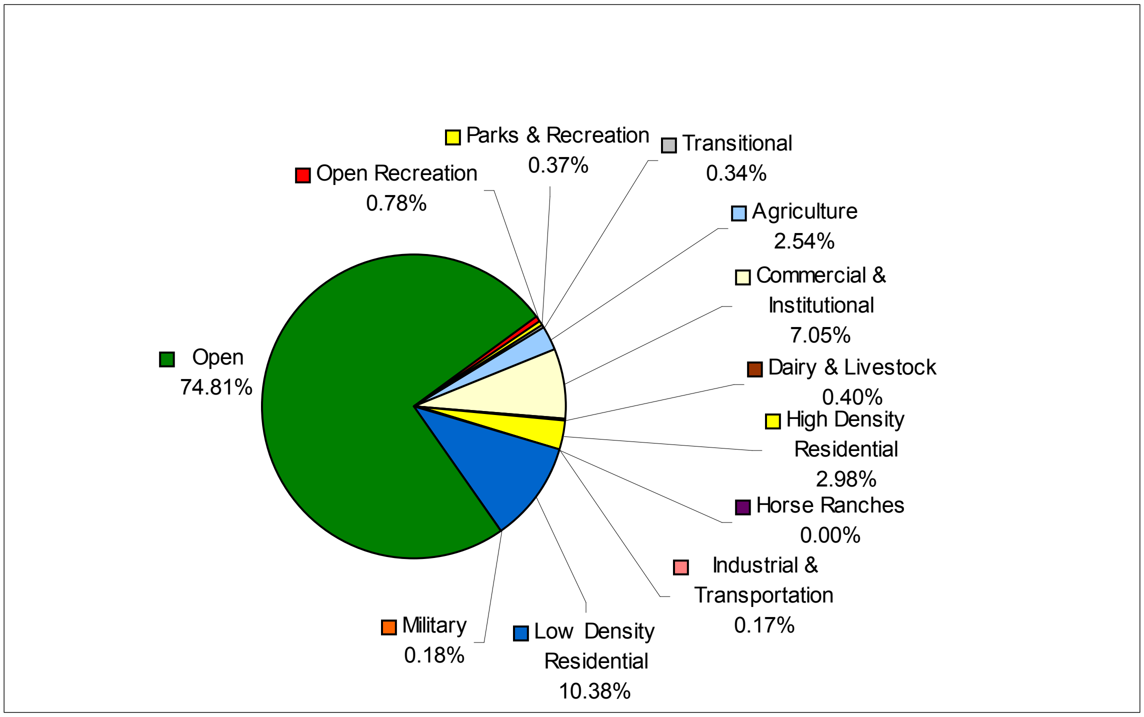


Figure I-39. Percent of Enterococci Load Generated by Different Land Uses in the San Diego River Watershed

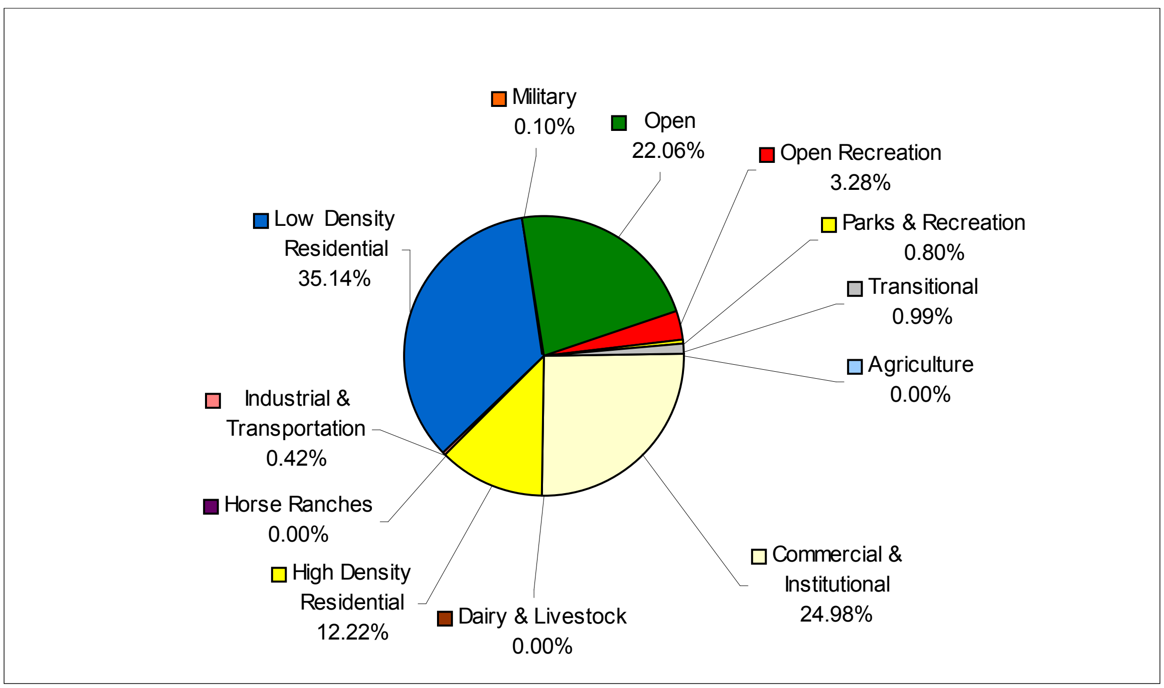


Figure I-40. Percent of Enterococci Load Generated by Different Land Uses in the Chollas Watershed

Table I-12. Fecal Coliform Loads (Billion MPN/year) Generated by Different Land Uses

Watershed	Low Density Residential	High Density Residential	Commercial/ Institutional	Industrial/ Transport	Military	Parks/Rec	Transitional	Dairy/ Intensive Livestock	Agriculture	Horse Ranches	Open Rec	Open Space	Water	**Total Existing Load**
Laguna/San Joaquin	12,902	32,219	3,102	212	0	1,058	28,201	0	0	7,332	212	619,708	0	705,015
	1.83%	4.57%	0.44%	0.03%	0.00%	0.15%	4.00%	0.00%	0.00%	1.04%	0.03%	87.90%	0.00%	100%
Aliso Creek	77,968	203,418	20,850	1,402	0	5,607	340,958	0	16,119	10,337	27,683	1,047,402	0	1,752,095
	4.45%	11.61%	1.19%	0.08%	0.00%	0.32%	19.46%	0.00%	0.92%	0.59%	1.58%	59.78%	0.00%	100%
Dana Point	27,870	77,107	2,100	0	0	2,222	69,715	0	0	0	25,123	199,734	0	403,911
	6.90%	19.09%	0.52%	0.00%	0.00%	0.55%	17.26%	0.00%	0.00%	0.00%	6.22%	49.45%	0.00%	100%
San Juan Creek	217,328	255,590	48,975	6,122	0	12,244	786,666	0	3,119,116	156,109	220,389	10,480,720	0	15,304,790
	1.42%	1.67%	0.32%	0.04%	0.00%	0.08%	5.14%	0.00%	20.38%	1.02%	1.44%	68.48%	0.00%	100%
San Clemente	37,917	76,411	7,209	2,163	288	3,028	128,601	0	433	0	38,350	1,147,176	0	1,441,719
	2.63%	5.30%	0.50%	0.15%	0.02%	0.21%	8.92%	0.00%	0.03%	0.00%	2.66%	79.57%	0.00%	100%
San Luis Rey River	281,520	142,416	23,184	6,624	453,744	9,936	29,808	1,397,665	19,289,095	0	89,424	11,396,596	0	33,120,012
	0.85%	0.43%	0.07%	0.02%	1.37%	0.03%	0.09%	4.22%	58.24%	0.00%	0.27%	34.41%	0.00%	100%
San Marcos	1,614	4,706	913	40	0	186	645	6,963	4,236	0	1,090	495	0	20,886
	7.73%	22.53%	4.37%	0.19%	0.00%	0.89%	3.09%	33.34%	20.28%	0.00%	5.22%	2.37%	0.00%	100%
San Dieguito River	381,036	121,335	55,346	4,257	0	8,515	240,542	1,136,721	10,734,988	0	149,008	8,455,160	0	21,286,909
	1.79%	0.57%	0.26%	0.02%	0.00%	0.04%	1.13%	5.34%	50.43%	0.00%	0.70%	39.72%	0.00%	100%
Miramar	1,316	5,428	50	1	0	46	0	0	0	0	0	3,552	0	10,392
	12.66%	52.23%	0.48%	0.01%	0.00%	0.44%	0.00%	0.00%	0.00%	0.00%	0.00%	34.18%	0.00%	100%
Scripps	27,976	85,479	11,060	41	0	939	2,918	0	0	0	20,059	55,585	0	204,057
	13.71%	41.89%	5.42%	0.02%	0.00%	0.46%	1.43%	0.00%	0.00%	0.00%	9.83%	27.24%	0.00%	100%
San Diego River	176,086	202,228	56,722	5,426	9,372	6,412	17,757	55,736	359,077	0	41,925	4,002,133	0	4,932,380
	3.57%	4.10%	1.15%	0.11%	0.19%	0.13%	0.36%	1.13%	7.28%	0.00%	0.85%	81.14%	0.00%	100%
Chollas Creek	117,270	163,103	39,674	2,536	1,087	2,657	10,386	0	0	0	34,541	232,487	0	603,863
	19.42%	27.01%	6.57%	0.42%	0.18%	0.44%	1.72%	0.00%	0.00%	0.00%	5.72%	38.50%	0.00%	100%

Table I-13. Total Coliform Loads (Billion MPN/year) Generated by Different Land Uses

Watershed	Low Density Residential	High Density Residential	Commercial/ Institutional	Industrial/ Transport including CalTrans	Military	Parks/Rec	Transitional	Dairy/ Intensive Livestock	Agriculture	Horse Ranches	Open Rec	Open Space	Water	**Total Existing Load**
Laguna/San Joaquin	371,630	742,438	216,236	7,400	0	30,421	295,988	0	0	50,976	2,467	6,503,524	0	8,221,902
	4.52%	9.03%	2.63%	0.09%	0%	0.37%	3.60%	0%	0%	0.62%	0.03%	79.10%	0%	100%
Aliso Creek	2,202,702	4,600,375	1,420,499	58,027	0	160,154	3,514,111	0	109,091	69,632	285,493	10,790,689	0	23,210,774
	9.49%	19.82%	6.12%	0.25%	0.00%	0.69%	15.14%	0.00%	0.47%	0.30%	1.23%	46.49%	0.00%	100%
Dana Point	893,006	1,977,837	162,365	655	0	72,017	814,442	0	0	0	293,304	2,333,337	0	6,546,962
	13.64%	30.21%	2.48%	0.01%	0.00%	1.10%	12.44%	0.00%	0.00%	0.00%	4.48%	35.64%	0.00%	100%
San Juan Creek	5,119,173	4,806,552	2,774,514	234,466	0	286,569	6,747,409	0	17,624,024	885,760	1,888,754	89,891,641	0	130,258,863
	3.93%	3.69%	2.13%	0.18%	0.00%	0.22%	5.18%	0.00%	13.53%	0.68%	1.45%	69.01%	0.00%	100%
San Clemente	1,022,902	1,648,009	470,860	87,677	3,247	82,806	1,264,826	0	1,624	0	376,688	11,276,277	0	16,236,540
	6.30%	10.15%	2.90%	0.54%	0.02%	0.51%	7.79%	0.00%	0.01%	0.00%	2.32%	69.45%	0.00%	100%
San Luis Rey River	6,670,042	2,686,545	1,343,272	231,599	3,914,018	208,439	254,759	7,920,675	109,430,375	0	787,436	98,174,679	0	231,598,677
	2.88%	1.16%	0.58%	0.10%	1.69%	0.09%	0.11%	3.42%	47.25%	0.00%	0.34%	42.39%	0.00%	100%
San Marcos	73,530	171,433	99,706	2,679	0	8,502	10,718	76,107	46,323	0	18,086	8,193	0	515,278
	14.27%	33.27%	19.35%	0.52%	0.00%	1.65%	2.08%	14.77%	8.99%	0.00%	3.51%	1.59%	0.00%	100%
San Dieguito River	9,289,136	2,371,346	3,287,177	130,833	0	228,958	2,126,035	6,656,124	62,897,919	0	1,324,683	75,212,567	0	163,541,132
	5.68%	1.45%	2.01%	0.08%	0.00%	0.14%	1.30%	4.07%	38.46%	0.00%	0.81%	45.99%	0.00%	100%
Miramar	39,360	129,900	3,578	43	0	1,363	0	0	0	0	0	38,742	0	212,986
	18.48%	60.99%	1.68%	0.02%	0.00%	0.64%	0.00%	0.00%	0.00%	0.00%	0.00%	18.19%	0.00%	100%
Scripps	922,414	2,255,236	874,633	2,012	0	30,680	35,207	0	0	0	240,914	667,920	0	5,029,518
	18.34%	44.84%	17.39%	0.04%	0.00%	0.61%	0.70%	0.00%	0.00%	0.00%	4.79%	13.28%	0.00%	100%
San Diego River	6,177,118	5,675,090	4,794,724	276,479	116,412	218,273	232,824	472,924	3,026,715	0	531,130	51,228,604	0	72,757,569
	8.49%	7.80%	6.59%	0.38%	0.16%	0.30%	0.32%	0.65%	4.16%	0.00%	0.73%	70.41%	0.00%	100%
Chollas Creek	4,001,558	4,452,503	3,252,035	129,281	13,852	90,805	129,281	0	0	0	429,398	2,891,895	0	15,390,608
	26.00%	28.93%	21.13%	0.84%	0.09%	0.59%	0.84%	0.00%	0.00%	0.00%	2.79%	18.79%	0.00%	100%

Table I-14. Enterococci Loads (Billion MPN/year) Generated by Different Land Uses

Watershed	Low Density Residential	High Density Residential	Commercial/ Institutional	Industrial/ Transport	Military	Parks/Rec	Transitional	Dairy/ Intensive Livestock	Agriculture	Horse Ranches	Open Rec	Open Space	Water	**Total Existing Load**
Laguna/San Joaquin	46,896	29,246	23,789	341	0	3,837	32,571	0	0	3,155	256	712,559	0	852,649
	5.50%	3.43%	2.79%	0.04%	0%	0.45%	3.82%	0%	0%	0.37%	0.03%	83.57%	0%	100%
Aliso Creek	275,653	179,755	155,445	2,676	0	20,072	381,811	0	6,914	4,460	31,000	1,172,642	0	2,230,206
	12.36%	8.06%	6.97%	0.12%	0.00%	0.90%	17.12%	0.00%	0.31%	0.20%	1.39%	52.58%	0.00%	100%
Dana Point	94,989	65,750	15,146	50	0	7,623	75,229	0	0	0	27,133	215,606	0	501,525
	18.94%	13.11%	3.02%	0.01%	0.00%	1.52%	15.00%	0.00%	0.00%	0.00%	5.41%	42.99%	0.00%	100%
San Juan Creek	637,323	186,913	302,436	11,682	0	36,344	729,482	0	1,096,818	54,516	205,086	9,720,795	0	12,980,098
	4.91%	1.44%	2.33%	0.09%	0.00%	0.28%	5.62%	0.00%	8.45%	0.42%	1.58%	74.89%	0.00%	100%
San Clemente	128,058	64,362	51,390	4,158	333	10,311	137,371	0	166	0	40,912	1,225,700	0	1,663,093
	7.70%	3.87%	3.09%	0.25%	0.02%	0.62%	8.26%	0.00%	0.01%	0.00%	2.46%	73.70%	0.00%	100%
San Luis Rey River	781,853	99,576	136,455	9,220	398,302	23,972	25,816	464,686	6,417,092	0	79,292	10,003,657	0	18,439,920
	4.24%	0.54%	0.74%	0.05%	2.16%	0.13%	0.14%	2.52%	34.80%	0.00%	0.43%	54.25%	0.00%	100%
San Marcos	9,401	6,850	11,153	126	0	1,087	1,188	4,867	2,961	0	2,012	913	0	40,558
	23.18%	16.89%	27.50%	0.31%	0.00%	2.68%	2.93%	12.00%	7.30%	0.00%	4.96%	2.25%	0.00%	100%
San Dieguito River	1,180,738	94,696	366,946	5,918	0	29,592	235,260	423,172	3,999,416	0	146,482	8,313,990	0	14,796,210
	7.98%	0.64%	2.48%	0.04%	0.00%	0.20%	1.59%	2.86%	27.03%	0.00%	0.99%	56.19%	0.00%	100%
Miramar	3,853	3,975	308	1	0	133	0	0	0	0	0	3,295	0	11,564
	33.32%	34.37%	2.66%	0.01%	0.00%	1.15%	0.00%	0.00%	0.00%	0.00%	0.00%	28.49%	0.00%	100%
Scripps	107,420	82,067	89,132	76	0	3,589	3,552	0	0	0	24,408	67,595	0	377,839
	28.43%	21.72%	23.59%	0.02%	0.00%	0.95%	0.94%	0.00%	0.00%	0.00%	6.46%	17.89%	0.00%	100%
San Diego River	753,148	216,222	511,531	12,335	13,060	26,846	24,670	29,023	184,296	0	56,595	5,428,033	0	7,255,759
	10.38%	2.98%	7.05%	0.17%	0.18%	0.37%	0.34%	0.40%	2.54%	0.00%	0.78%	74.81%	0.00%	100%
Chollas Creek	482,111	167,655	342,719	5,762	1,372	10,976	13,583	0	0	0	45,001	302,657	0	1,371,972
	35.14%	12.22%	24.98%	0.42%	0.10%	0.80%	0.99%	0.00%	0.00%	0.00%	3.28%	22.06%	0.00%	100%

Table I-15. Loads Generated by Caltrans: Fecal Coliform

Watershed	Measure/Unit	Industrial/Transport including CalTrans	Industrial/ Transport excluding Caltrans	Caltrans
Laguna/San Joaquin	Area (sq miles)	0.11		0.19
	% Area of Ind./Trans		0.00%	
	Load (Billion MPN/Yr)	212	0	212
Aliso Creek	Area (sq miles)	0.89	0.72	0.17
	% Area of Ind./Trans		80.90%	19.10%
	Load (Billion MPN/Yr)	1,402	1,134	268
Dana Point	Area (sq miles)	0.01		0.06
	% Area of Ind./Trans		0.00%	
	Load (Billion MPN/Yr)	0	0	0
San Juan Creek	Area (sq miles)	2.9	2.17	0.73
	% Area of Ind./Trans		74.83%	25.17%
	Load (Billion MPN/Yr)	6,122	4,581	1,541
San Clemente	Area (sq miles)	1.17	0.99	0.18
	% Area of Ind./Trans		84.62%	15.38%
	Load (Billion MPN/Yr)	2,163	1,830	333
San Luis Rey River	Area (sq miles)	4.92	3.75	1.17
	% Area of Ind./Trans		76.22%	23.78%
	Load (Billion MPN/Yr)	6,624	5,049	1,575
San Marcos	Area (sq miles)	0.05	0.04	0.01
	% Area of Ind./Trans		80.00%	20.00%
	Load (Billion MPN/Yr)	40	32	8
San Dieguito River	Area (sq miles)	2.22	1.44	0.78
	% Area of Ind./Trans		64.86%	35.14%
	Load (Billion MPN/Yr)	4,257	2,762	1,496
Miramar	Area (sq miles)	3.28	2.54	0.74
	% Area of Ind./Trans		77.44%	22.56%
	Load (Billion MPN/Yr)	1	1	0
Scripps	Area (sq miles)	0.05	0.05	0
	% Area of Ind./Trans		100.00%	0.00%
	Load (Billion MPN/Yr)	41	41	0
San Diego River	Area (sq miles)	10.07	8.13	1.94
	% Area of Ind./Trans		80.73%	19.27%
	Load (Billion MPN/Yr)	5,426	4,380	1,045
Chollas Creek	Area (sq miles)	1.61	1.04	0.57
	% Area of Ind./Trans		64.60%	35.40%
	Load (Billion MPN/Yr)	2,536	1,638	898

Table I-16. Loads Generated by Caltrans: Total Coliform

Watershed	Measure/Unit	Industrial/ Transport	Industrial/ Transport excluding Caltrans	Caltrans
Laguna/San Joaquin	Area (sq miles)	0.11		0.19
	% Area of Ind./Trans	0.79%	0.00%	
	Load (Billion MPN/Yr)	7,400	0	7,400
Aliso Creek	Area (sq miles)	0.89	0.72	0.17
	% Area of Ind./Trans	2.49%	80.90%	19.10%
	Load (Billion MPN/Yr)	58,027	46,943	11,084
Dana Point	Area (sq miles)	0.01		0.06
	% Area of Ind./Trans	0.11%	0.00%	
	Load (Billion MPN/Yr)	655	0	655
San Juan Creek	Area (sq miles)	2.9	2.17	0.73
	% Area of Ind./Trans	1.64%	74.83%	25.17%
	Load (Billion MPN/Yr)	234,466	175,445	59,021
San Clemente	Area (sq miles)	1.17	0.99	0.18
	% Area of Ind./Trans	6.23%	84.62%	15.38%
	Load (Billion MPN/Yr)	87,677	74,188	13,489
San Luis Rey River	Area (sq miles)	4.92	3.75	1.17
	% Area of Ind./Trans	0.88%	76.22%	23.78%
	Load (Billion MPN/Yr)	231,599	176,523	55,075
San Marcos	Area (sq miles)	0.05	0.04	0.01
	% Area of Ind./Trans	3.50%	80.00%	20.00%
	Load (Billion MPN/Yr)	2,679	2,144	536
San Dieguito River	Area (sq miles)	2.22	1.44	0.78
	% Area of Ind./Trans	0.64%	64.86%	35.14%
	Load (Billion MPN/Yr)	130,833	84,865	45,968
Miramar	Area (sq miles)	3.28	2.54	0.74
	% Area of Ind./Trans	3.50%	77.44%	22.56%
	Load (Billion MPN/Yr)	43	33	10
Scripps	Area (sq miles)	0.05	0.05	0
	% Area of Ind./Trans	0.57%	100.00%	0.00%
	Load (Billion MPN/Yr)	2,012	2,012	0
San Diego River	Area (sq miles)	10.07	8.13	1.94
	% Area of Ind./Trans	2.31%	80.73%	19.27%
	Load (Billion MPN/Yr)	276,479	223,215	53,264
Chollas Creek	Area (sq miles)	1.61	1.04	0.57
	% Area of Ind./Trans	6.01%	64.60%	35.40%
	Load (Billion MPN/Yr)	129,281	83,511	45,770

Table I-17. Loads Generated by Caltrans: Enterococci

Watershed	Measure/Unit	Industrial/ Transport	Industrial/ Transport excluding Caltrans	Caltrans
Laguna/San Joaquin	Area (sq miles)	0.11		0.19
	% Area of Ind./Trans		0.00%	
	Load (Billion MPN/Yr)	341	0	341
Aliso Creek	Area (sq miles)	0.89	0.72	0.17
	% Area of Ind./Trans		80.90%	19.10%
	Load (Billion MPN/Yr)	2,676	2,165	511
Dana Point	Area (sq miles)	0.01		0.06
	% Area of Ind./Trans		0.00%	
	Load (Billion MPN/Yr)	50	0	50
San Juan Creek	Area (sq miles)	2.9	2.17	0.73
	% Area of Ind./Trans		74.83%	25.17%
	Load (Billion MPN/Yr)	11,682	8,741	2,941
San Clemente	Area (sq miles)	1.17	0.99	0.18
	% Area of Ind./Trans		84.62%	15.38%
	Load (Billion MPN/Yr)	4,158	3,518	640
San Luis Rey River	Area (sq miles)	4.92	3.75	1.17
	% Area of Ind./Trans		76.22%	23.78%
	Load (Billion MPN/Yr)	9,220	7,027	2,193
San Marcos	Area (sq miles)	0.05	0.04	0.01
	% Area of Ind./Trans		80.00%	20.00%
	Load (Billion MPN/Yr)	126	101	25
San Dieguito River	Area (sq miles)	2.22	1.44	0.78
	% Area of Ind./Trans		64.86%	35.14%
	Load (Billion MPN/Yr)	5,918	3,839	2,079
Miramar	Area (sq miles)	3.28	2.54	0.74
	% Area of Ind./Trans		77.44%	22.56%
	Load (Billion MPN/Yr)	1	1	0
Scripps	Area (sq miles)	0.05	0.05	0
	% Area of Ind./Trans		100.00%	0.00%
	Load (Billion MPN/Yr)	76	76	0
San Diego River	Area (sq miles)	10.07	8.13	1.94
	% Area of Ind./Trans		80.73%	19.27%
	Load (Billion MPN/Yr)	12,335	9,958	2,376
Chollas Creek	Area (sq miles)	1.61	1.04	0.57
	% Area of Ind./Trans		64.60%	35.40%
	Load (Billion MPN/Yr)	5,762	3,722	2,040

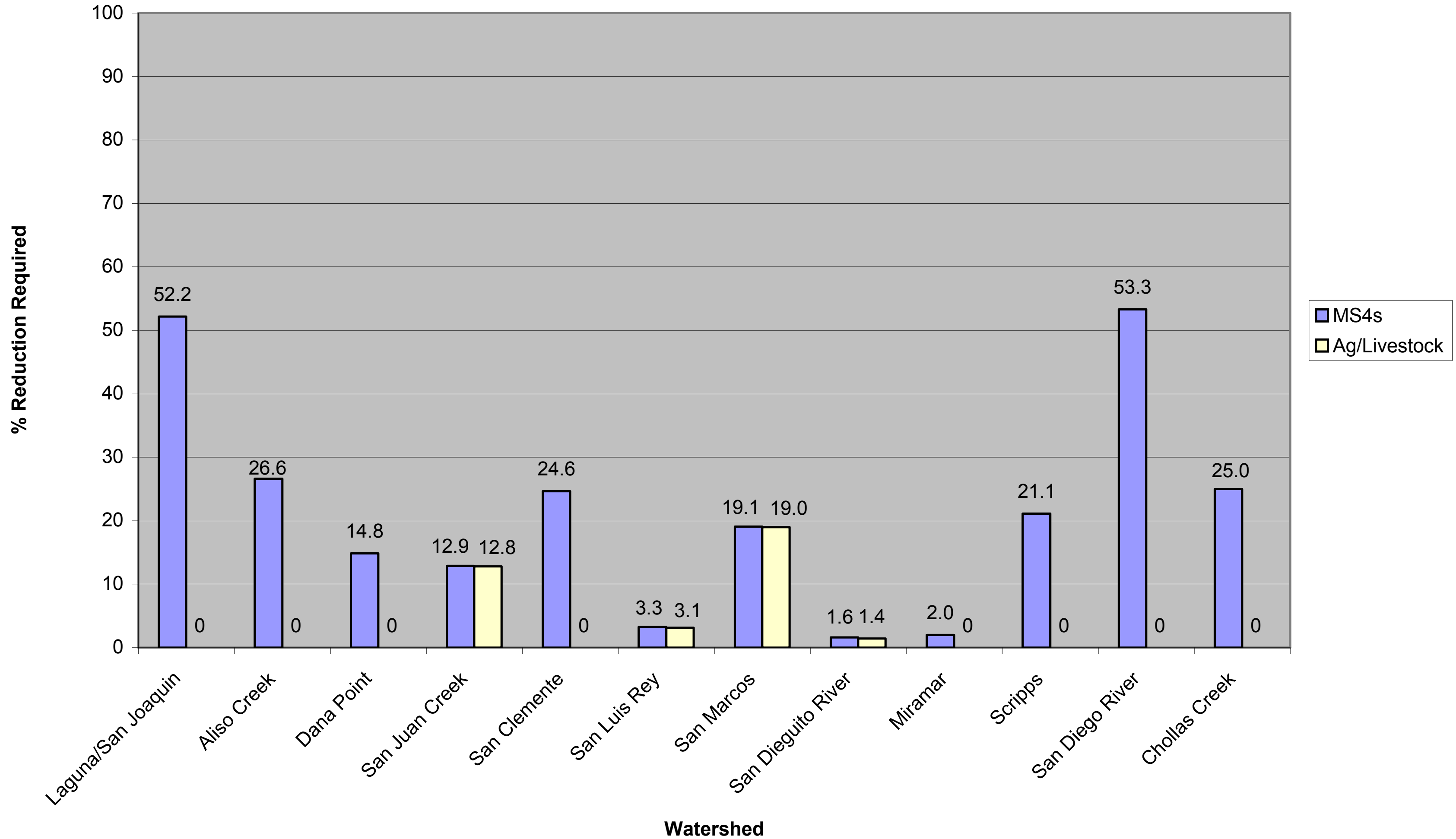


Figure I-41. Wet Weather Fecal Coliform Loads: Percent Reduction Required from Controllable Sources to Meet Interim TMDLs

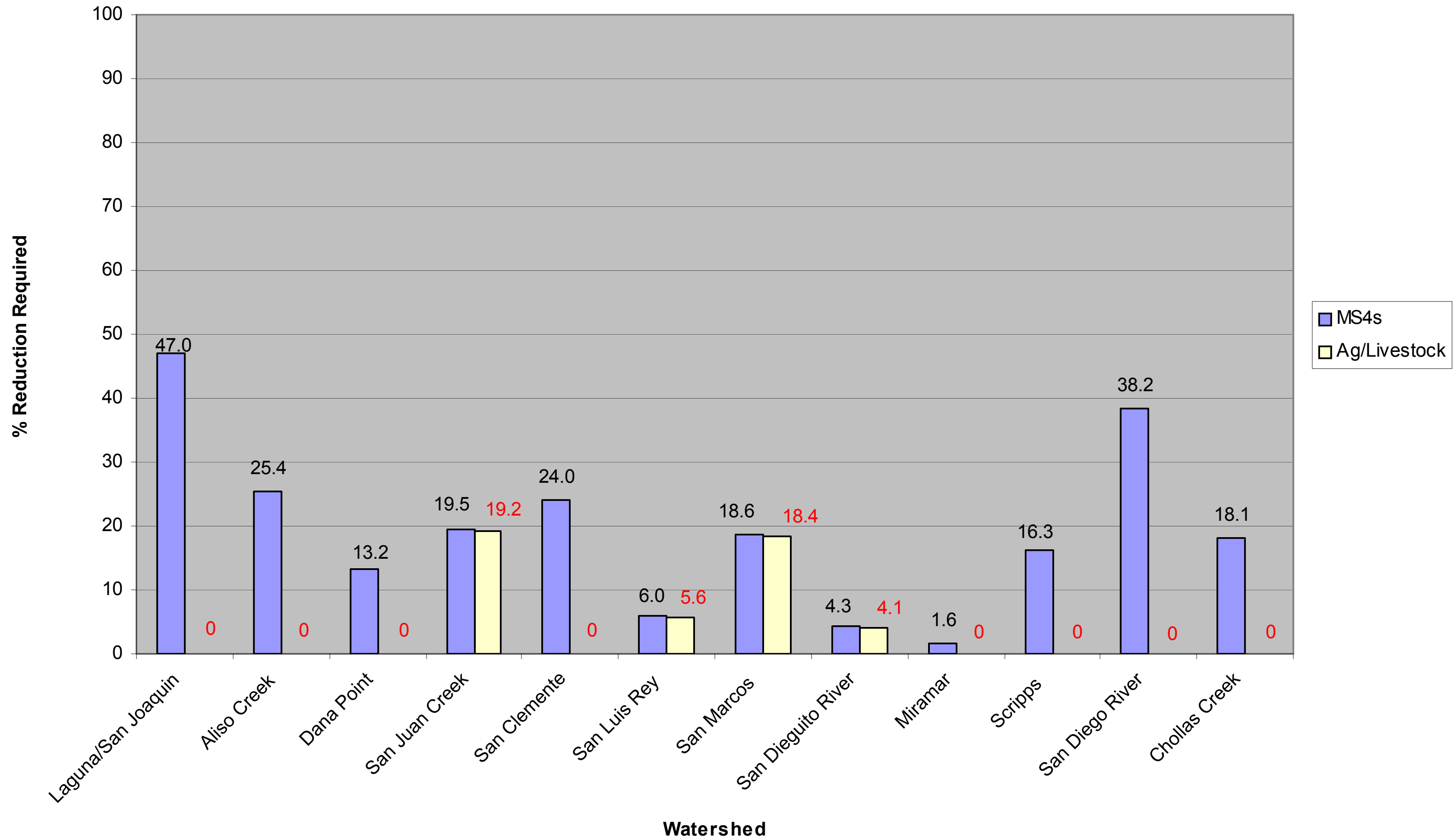


Figure I-42. Wet Weather Total Coliform Loads: Percent Reduction Required from Controllable Sources to Meet Interim TMDLs

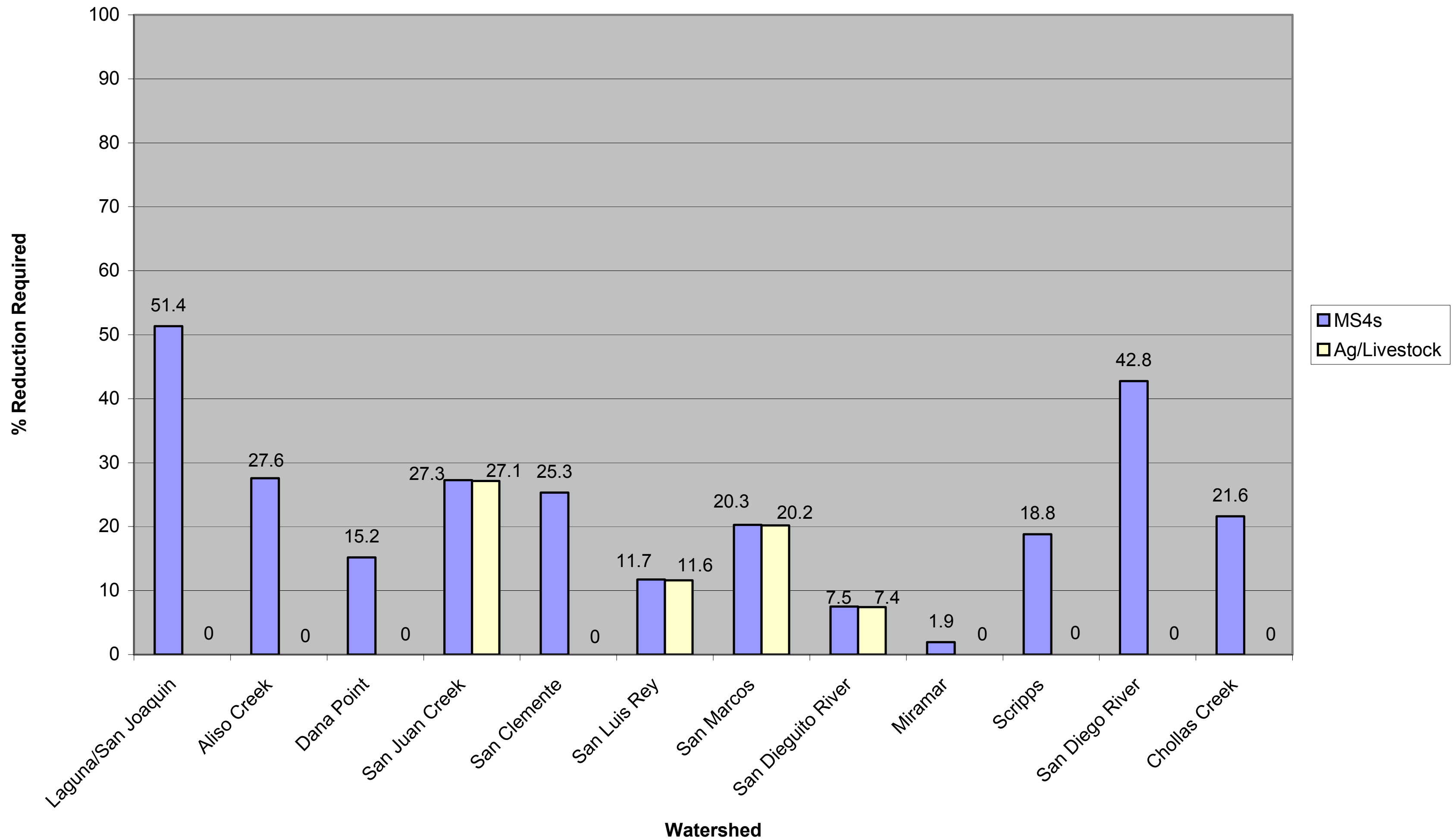


Figure I-43. Wet Weather Enterococci Loads: Percent Reduction Required from Controllable Sources to Meet Interim TMDLs